AP Environmental Science Syllabus

Course Overview

HPA is a boarding school with a 6 day modular class schedule. Regular classes meet approx. 190 minutes per week, with additional "X" periods providing extra contact time to an average of 210 minutes per week. The school year starts in early August and ends in late May, with a rather long winter break to allow students time to return home (we have many international students). We try to wrap up the courses as outlined below at least two weeks prior to the AP exam, which leaves us quite a bit shorter than the 180 days of instruction in a normal school year.

We combine both textbook and online resources as teaching materials. Our primary texts are Environmental Science, Richard Wright, 10th edition, 2008 Prentice Hall, and the Barron's AP review text. We supplement these with online simulations (MITE AP Environmental Science simulations, see below) and the Princeton Review AP exam prep books, as well as the NREL curriculum materials (see below). We also have a plethora of past exams for practice and evaluation through the year.

Our labs are interactive hands-on affairs, extensively using the Vernier data acquisition program Logger Pro 3.5 (see below), and the graphical analysis program (Graphical Analysis) from the same company. We use a weblog system to allow for dissemination of our assignments with a comment system built in (Apple's Mac OSX Leopard Server weblog, based on the Blojsom open source system).

Online grading is done using the Gradekeeper program with a web export for student and parent use.

Labs follow a standard format (see below) outlined by the University of California system. Peer coaching and peer review are an active part of our education process, as the students work collaboratively on labs and homework, while exams and quizzes are randomized versions using an interactive spreadsheet program developed by the instructor. Guided inquiry is a fundamental aspect of our labs, as students are asked to determine relationships, if any between measurable phenomena with the tools provided. Critical thinking skills are tested and developed in the review and re-grading of the labs, which is motivated with the use of "super corrections" where students may gain a higher lab grade for making corrections to a lab report. Since all reports are html or pdf format, they are shared on the students' website for review by the instructor as well as peers. This becomes a lab portfolio that remains long after the student completes the course. Labs generally take at least one 90 minute class period, which is often supplemented by work over the lunch periods.

Homework is assigned at every class, and reviewed in class after an initial quiz that begins each class. A complete record of the past several years' weekly plan is available on the weblog (see reference below).

Textbooks/Resources

Primary textbook
Environmental Science, Richard Wright, 10th edition, 2008 Prentice Hall

Princeton Review for the AP Environmental Science exam:
Princeton Review, 2007
ISBN 978-0375428449

Monterey Institute for Technology and Education
http://www.archive.org/details/ap_courses

AP Environmental Science Course: Encyclopedia of Earth
Boston University and National Council for Science and the Environment:
http://www.eoearth.org/article/AP_Environmental_Science_%28course%29

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Vernier lab software and hardware
http://www.vernier.com

Online weblogs:
http://facstaff.hpa.edu/weblog/bwiecking

Online Grades:

http://facstaff.hpa.edu/~bwiecking/grades

AP Environmental Science Topic Outline

1. Earth systems and resources
    1. Earth science concepts
        1. Geologic time scale
            - Geologic time
        2. Plate tectonics
            - Plate tectonics
        3. Earthquakes
            - Earthquake
        4. Volcanism
            - Volcano
        5. Seasons
            - Earth-Sun geometry
        6. Solar intensity and latitude
            - Earth-Sun relationships and insolation
            - Solar radiation
    2. The Atmosphere
        1. Composition
            - Atmospheric composition
            - Atmospheric composition and structure
        2. Structure
            - Atmosphere layers
        3. Weather and climate
            - Tropical weather and hurricanes
        4. Atmospheric circulation and Coriolis Effect
            - Global-scale circulation of the atmosphere
        5. Atmosphere-ocean interactions
            - Global coupled atmosphere-ocean general circulation models
        6. El Niño-Southern Oscillation (ENSO)
            - El Niño, La Niña and the southern oscillation
            - El Nino and bacillary dysentery
    3. Global water resources and use
        1. Freshwater
            - Surface runoff of water
            - Groundwater
            - Freshwater biomes
            - River
            - Stream
            - Aquifer
        2. Saltwater
            - Seawater
        3. Ocean circulation
            - Ocean circulation
        4. Agriculture, industrial, and domestic use
        5. Surface and groundwater issues
            - Surface water management

- Surface runoff of water
- Groundwater
- Aquifer depletion
- TCE contamination of groundwater
- Effect of climate change and land use change on saltwater intrusion

6. Global problems
   - Water
   - Water resources
   - Water governance
   - Governance of water resources in Africa
   - Society and water resources
   - Water profile articles, for example Water profile of Kuwait
7. Conservation
   - Transborder conservation

4. Soil and soil dynamics
   1. Rock cycle
      - Rock cycle
   2. Formation
      - Formation of the Earth's crust
      - Soil forming factors
   3. Composition
      - Composition of rocks
   4. Physical and chemical properties
   5. Main soil types
   6. Erosion and other soil problems
      - Soil erosion and deposition
   7. Soil conservation

2. The Living World
   1. Ecosystem structure
      1. Biological populations and communities
      2. Ecological niche
      3. Interactions among species
      4. Keystone species
      5. Species diversity and edge effects
         - Biological diversity
         - Species diversity
      6. Major terrestrial and aquatic biomes
         - Biome
         - Terrestrial biome
         - Freshwater biomes
         - Marine biomes
         - Tundra biome
         - Grassland biome
         - Desert biome
         - Forest biome
   2. Energy flow
      1. Photosynthesis and cellular respiration
         - Photosynthesis
      2. Food webs and tropic levels
      3. Ecological pyramids
   3. Ecosystem diversity
      1. Biodiversity
         - Biodiversity
      2. Natural selection
         - Natural selection
      3. Evolution
      4. Ecosystem services
         - Biodiversity and ecosystem services

4. Natural ecosystem change
    1. Climate shifts
        - Earth's climatic history
    2. Species movement
    3. Ecological succession
5. Natural biogeochemical cycles
    1. Carbon
        - Carbon cycle
    2. Nitrogen
        - Nitrogen cycle
    3. Phosphorus
    4. Sulfur
    5. Water
        - Hydrologic cycle
    6. Conservation of matter

3. Population
    1. Population biology concepts
        1. Population ecology
        2. Carrying capacity
            - Carrying capacity
        3. Reproductive strategies
        4. Survivorship
    2. Human population
        1. Human population dynamics
            1. Historical population sizes
                - Human population explosion
            2. Distribution
            3. Fertility rates
            4. Growth rates and doubling times
                - Population growth rate
            5. Demographic transition
            6. Age-structure diagrams
        2. Population size
            1. Strategies for sustainability
            2. Case studies
            3. National policies
        3. Impacts of population growth
            1. Hunger
            2. Disease
            3. Economic effects
            4. Resource use
            5. Habitat destruction
                - Ecological footprint
                - Land-use and land-cover change

4. Land and water use
    1. Agriculture
        - Agriculture
        1. Feeding a growing population
            1. Human nutritional requirements
            2. Types of agriculture
            3. Green Revolution
            4. Genetic engineering and crop production
            5. Deforestation
                - Deforestation in Amazonia
            6. Irrigation
            7. Sustainable agriculture
        2. Controlling pests
            1. Types of pesticides

- Pesticide

2. Costs and benefits of pesticide use
   - Agricultural pesticide contamination
3. Integrated pest management
4. Relevant laws
   - Federal Insecticide, Fungicide and Rodenticide Act, United States

2. Forestry
   1. Tree plantations
   2. Old growth forests
   3. Forest fires
      - Monitoring forest fire danger with remote sensing
      - Fire in America
   4. Forest management
      - Forestry
   5. National forests
3. Rangelands
   1. Overgrazing
   2. Deforestation
      - Deforestation in Amazonia
   3. Desertification
   4. Rangeland management
   5. Federal rangelands
4. Other land use
   1. Urban land development
      1. Planned development
      2. Suburban sprawl
      3. Urbanization
         - Urbanization
   2. Transportation infrastructure
      1. Federal highway system
         - Roads and highways in the United States
      2. Canals and channels
      3. Roadless areas
      4. Ecosystem impacts
         - Road ecology
   3. Public and federal lands
      1. Management
      2. Wilderness areas
      3. National parks
      4. Wildlife refuges
      5. Forests
      6. Wetlands
         - Wetland
   4. Land conservation options
      1. Preservation remediation
      2. Mitigation
      3. Restoration
   5. Sustainable land-use strategies
5. Mining
   1. Mineral formation
   2. Extraction
   3. Global reserves
   4. Relevant laws and treaties
      - Surface Mining Control and Reclamation Act of 1977, United States
      - Mining Law of 1872, United States
      - Federal Mine Safety and Health Act of 1977, United States
6. Fishing

1. Fishing techniques
   - Marine fisheries
2. Overfishing
3. Aquaculture
   - Fisheries and Aquaculture
   - Fisheries and aquaculture in the Northeast Atlantic (Barents and Norwegian Seas)
4. Relevant laws and treaties
   - Atlantic Coastal Fisheries Cooperative Management Act, United States
   - Atlantic States Marine Fisheries Commission, United States
   - Interjurisdictional Fisheries Act of 1986, United States
   - Magnuson-Stevens Fishery Conservation and Management Act, United States

7. Global economics
   1. Globalization
      - Global economy
      - Globalization and environmental politics
   2. World Bank
   3. Tragedy of the commons
      - Tragedy of the Commons (historical)
   4. Relevant laws and treaties

5. Energy resources and consumption -> for overview see [1]
   1. Energy concepts
      1. Energy forms
      2. Power
      3. Units
         - International System of Units (SI)
         - Joule
         - Watt
      4. Conversions
      5. Law of Thermodynamics
         - Thermodynamics
   2. Energy consumption
      1. History
         1. Industrial Revolution
            - Industrial Revolution
         2. Exponential growth
         3. Energy crisis
      2. Present global energy use
      3. Future energy needs
   3. Fossil fuel resources and use
      1. Formation of coal, oil and natural gas
         - Coal
      2. Extraction/purification methods
      3. World reserves and global demand
      4. Synfuels
      5. Environmental advantages/disadvantages of sources
   4. Nuclear energy
      1. Nuclear fission process
      2. Nuclear fuel
         - Nuclear fuel cycle
      3. Electricity production
      4. Nuclear reactor types
         - Nuclear power reactor
         - Fast neutron reactors (FBR)
         - Generation IV nuclear reactors
         - Advanced nuclear power reactors
         - Small nuclear power reactors

- Research reactors
- Nuclear reactors for space
- Light water graphite reactor (RBMK)

5. Environmental advantages/disadvantages
6. Safety issues
   - Safety of nuclear power reactors
7. Radiation and human health
   - Health effects of ionizing radiation
8. Radioactive waste
   - Nuclear waste management
9. Nuclear fusion
   - Nuclear fusion power

5. Hydroelcetrc power
   1. Dams
   2. Flood control
   3. Salmon
   4. Silting
   5. Other impacts
6. Energy Conservation
   1. Energy efficiency
   2. CAFE standards
   3. Hybrid electric vehicles
   4. Mass transit
7. Renewable Energy
   1. Solar energy
      - Solar energy
   2. Solar electricity
   3. Hydrogen fuel cell
      - Fuel cells
   4. Biomass
   5. Wind energy
      - Wind farm
   6. Small-scale hydroelectric
   7. Ocean waves and tidal energy
   8. Geothermal
   9. Environmental advantages/disadvantages

6. Pollution
   1. Pollution types
      1. Air pollution
         - Air pollution emissions
         - Impacts of air pollution on local to global scale
         - Air quality index
      2. Sources: primary and secondary
      3. Major air pollutants
      4. Measurement units
      5. Smog
         - Smog
      6. Acid deposition: causes and effects
         - Acid rain
      7. Heat island and temperature inversions
         - Heat island
      8. Indoor air pollution
         - Indoor air quality (IAQ)
      9. Remediation and reduction strategies
      10. Clean Air Act and other relevant laws
         - Clean Air Act, United States
      11. Noise pollution
         1. Sources

2. Effects
3. Control measures

12. Water pollution
    1. Types
        - Eutrophication
    2. Sources, causes, and effects
    3. Cultural eutrophication
        - Impact and abatement of acid deposition and eutrophication
    4. Groundwater pollution
        - groundwater
        - see also articles such as TCE contamination of groundwater
    5. Maintaining water quality
        - Clean Water Act, United States
    6. Water purification
    7. Sewage treatment/septic systems
    8. Clean Water Act and other relevant laws
        - Clean Water Act, United States
13. Soil waste
    1. Types
    2. Disposal
    3. Reduction

2. Impacts on the environment and human health
    1. Hazards to human health
        - Toxicology
        - also see selected articles on specific toxicants, for example Health effects of Polychlorinated biphenyls
        1. Environmental risk analysis
            - Risk Assessment
        2. Acute and chronic effects
            - see acute and chronic sections of Toxicity
        3. Dose-response relationships
            - Dose-response relationship
        4. Air pollutants
            - Impact of local air pollution
        5. Smoking and other risks
    2. Hazardous chemicals in the environment
        - see selected articles on specific toxicants, for example Health effects of Polychlorinated biphenyls
        1. Types of hazardous waste
        2. Treatment/disposal of hazardous waste
            - Transboundary dumping of hazardous waste
        3. Cleanup of contaminated sites
        4. Biomagnification
        5. Relevant laws
            - Regulation of toxic chemicals
            - CERCLA
            - SARA
3. Economic impacts
    1. Cost-benefit analysis
        - Cost-benefit analysis and economic assessment
    2. Externalities
        - Externality
    3. Marginal costs
    4. Sustainability
        - Sustainability

7. Global change
    1. Stratospheric ozone
        - Ozone

- for more in depth see Stratospheric Ozone Depletion by Chlorofluorocarbons (Nobel Lecture)

1. Formation of stratospheric ozone
2. Ultraviolet radiation
   - Solar radiation
   - Electromagnetic radiation
3. Causes of ozone depletion
4. Effects of ozone depletion
   - Impact of ozone on climate change
   - Impact of ozone on health and vegetation
5. Strategies for reducing ozone depletion
6. Relevant laws and treaties
   - Montreal Protocol on Substances that Deplete the Ozone Layer

2. Global warming --> Global warming
   1. Greenhouse gases and the greenhouse effect
      - Greenhouse gas
      - Greenhouse effect
      - Carbon dioxide
      - Methane
      - Nitrous oxide
   2. Impacts and consequences of global warming
      - Global warming impacts
   3. Reducing climate change
      - Greenhouse gas mitigation in agriculture
      - Carbon capture and storage
   4. Relevant laws and treaties
      - Kyoto Protocol
      - Kyoto Protocol to the United Nations Framework Convention on Climate Change (full text)
      - United Nations Framework Convention on Climate Change (full text)
      - United States federal laws and policies related to greenhouse gas reductions
3. Loss of biodiversity
   - for more detail see [2]
   1. Habitat loss
      1. Oveuse
      2. Pollution
      3. Introduced species
         - Marine invasive species
      4. Endangered and extinct species
   2. Maintenance through conservation
   3. Relevant laws and treaties
      - Endangered Species Act, United States

Lab Format:
Our labs follow the University of California system format, not because I went there, but because it has become the college standard:

Title

Purpose

Background

Materials

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Procedure

Data

Observations

Analysis

Conclusions

Here's a summary of each:

Title-what the lab is about, should be short and to the point

Purpose-what you hope to accomplish. Should be later addressed in conclusions

Background-any information that will make your lab easier to understand for the reader, a sense of context.

Materials-non-obvious things you will need to do the lab (you need not list oxygen, table, floor, etc.)

Procedure-detailed steps to follow to duplicate your lab. Think of it this way: could you follow these instructions and complete the lab if you were absent that day?

Data-anything you gather that is not in words: graphs, tables, results

Observations-any results not in numeric form, e.g. "My partner ran fastest when he was on fire"

Analysis-look at your data: does it make sense? Is your experiment a failure in what you were trying to find, but a success in finding something else?

Conclusions-address the purpose, and list ways you could improve the lab for the next person.

Lab Syllabus:

1. Solubility of gases: To illustrate the differences between basaltic and andesitic lava, carbon dioxide is carried in cool and warm water, to determine relative gas content.

2. Theodolite lab: measuring sun elevation, star positions, tracking solar path: year and day

3. Solar insolation: using closed containers, albedo is studied and its calculation using black body radiation formulas.

4. Atmospheric lab: Mauna Loa Atmospheric Observatory visit/follow-up Video teleconference and lab.

5. Keahole Ocean Thermal Energy Conversion lab visit, follow-up VTC, lab.

6. Stream study: Hawaiian Ahupua'a: a sample ecosystem from 2000 meters to sea

7. Melting point of basaltic rocks: using fresnel lens, we melt common Hawaiian rocks, using IR thermometer to determine melting point

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8. Mauna Kea State Park: Lake Waiau-ancient glacier lab

9. Chlorophyll absorption lab: liquid chromatography of common plants with visible analysis

10. NPK analysis of common fertilizers and effects on growth rates: corn and beans contrasted as nitrogen fixers/consumers

11. Exponential Decay and growth: Using cooling rates for hot water, we determine the mathematical analysis of exponential decay, and in reverse, exponential growth using the natural logarithm function. This is then related to population growth/decay.

12. Global footprint lab: VTC with scientists from global footprint.org (Oakland, CA), follow up lab on school global energy footprint and global impact footprint.

13. Google maps study of deforestation: visual study lab using GIS tools (arcview, LIDAR)

14. Koaia Forest preserve: last existing sandalwood preserve in the state. Coupled with fire re-emergence study near Nohonohae cinder cone (Pu'u).

15. Waipio freshwater biome lab: study of water quality from source to sea, human impact. Cooperative studies with dry-land taro studies (terraced farming above campus)

16. Aquaculture lab: Keahole Kampachi aquafarm study, meet with farm owners. Correlate with Keahole algae farmers.

17. Sustainability: learning from ancient Hawaiians about cooperative farming/societies in the Waipio/ Kohala terraced farming zones.

18. Tragedy of the commons: Internet access in the dorms-a case study.

19. Power lab: HP developed running up hill

20. Carbon dioxide growth lab: Mauna Loa Observatory studies, coupled with historical industrial revolution data, and with China coal production forecasts.

21. Biofuels lab: Bioethanol and Biodiesel labs: Production and evaluation of two carbon neutral energy transfer methods: which is truly carbon neutral and why?

22. Nuclear energy modeling lab: neutron cross sections, fission vs. fusion processes, thermal runaway models, radiation safety lab.

23. Energy efficiency lab: School electrical use study

24. Renewable energy labs: Solar thermal, PV and wind generators evaluated and compared: energy, lifespan, ROI.

25. Outreach lab: energy surveys for local homes/businesses, determine best steps to reduce energy use and increase sustainable practices

26. Vognet lab: volcanic air pollution measured and effects considered.

27. Eutrophication: decline of anchialine ponds and Mauna Lani fishponds due to Golf course runoff.

28. Toxicology: LD50 study of common pesticides, historical study lab, whole body analysis.

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29.Embargo! Island economy lab: determine effects of island embargo

30.Global change: Mauna Loa Observatory Ozone measurements, ozone depletion

31.Global Change II: MLO carbon dioxide measurements, global warming implications, forecasts.

32. Invasive species lab: Coqui frog, arboretum VTC, Banana top virus study.

33.Coral test case: coral bleaching and temperature/salinity trends

Appendix:

Instructor's Websites:

http://facstaff.hpa.edu/weblog/bwiecking

http://physics.hpa.edu

Dr. Bill Wiecking

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Kamuela, Hawaii