Goal 6: Environmental Science

The student will demonstrate the ability to use the scientific skills and processes (Core Learning Goal 1) and major environmental science concepts to understand interrelationships of the natural world and to analyze environmental issues and their solutions.

1. Expectation: The student will explain how matter and energy move through the biosphere (lithosphere, hydrosphere, atmosphere and organisms).

A. Indicators of Learning

(1) The student will demonstrate that matter cycles through and between living systems and the physical environment constantly being recombined in different ways.

At least —

- nitrogen cycle
- carbon cycle
- phosphorus cycle (rock/mineral)
- hydrologic cycle

(2) The student will analyze how the transfer of energy between atmosphere, land masses and oceans results in areas of different temperatures and densities that produce weather patterns and establish climate zones around the earth.

At least —

- differential heating and cooling
- oceanic and atmospheric circulation patterns
- climates and microclimates
- biomes

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

Students are involved in growing soy beans and rye grass in the classroom to investigate the impact of bacteria living in a symbiotic relationship in the root nodules of the soy plants. The students analyze the soil for differences in the amount of nitrogen. They design an investigation to determine the effect of varying levels of nitrogen on the biomass of each of the plants. Data is collected over a period of time and displayed in graph form. Students construct laboratory reports that summarize their findings and apply them to agricultural practices in the region. Decisions are made concerning the best methods of crop fertilization in their region.

2. Expectation: The student will investigate the interdependence of organisms within their biotic environment.

A. Indicators of Learning

(1) The student will explain how organisms are linked by the transfer and transformation of matter and energy at the ecosystem level.

At least —

- Photosynthesis/respiration
- Producers, consumers, decomposers
- Trophic levels
- Pyramid of energy/pyramid of biomass

(2) The student will explain why interrelationships & interdependencies of organisms contribute to the dynamics of ecosystems.

At least —

- Interspecific and intraspecific competition
- Niche
- Cycling of materials among organisms
- Equilibrium/cyclic fluctuations
- Dynamics of disturbance and recovery
- Succession: aquatic and terrestrial

(3) The student will conclude that populations grow or decline due to a variety of factors.

At least —

- Linear/exponential growth
- Carrying capacity/limiting factors
- Species specific reproductive factors (such as birth rate, fertility rate)
- Factors unique to the human population (medical, agricultural, cultural)
- Immigration/emigration
- Introduced species

(4) The student will provide examples and evidence showing that natural selection leads to organisms that are well suited for survival in particular environments.

At least —

- coevolutionary relationships, e.g. symbiotic relationships
- variation within a species increases survival potential
- natural selection provides a mechanism for evolution
- adaptations of organisms within biomes

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

Students examine owl pellets in terms of content and mass to determine the owl's niche and its trophic level in the food chain. Discussions occur as to the digestion process, when and where the owl feeds, on what it feeds and the biomass necessary to support the owl in terms of herbivores and producers. Students construct a food web diagram and draw a pyramid of biomass depicting the organisms necessary to support the owl. Students discuss possible situations where the owl might be used as a biological control of rodent populations.

3. Expectation: The student will analyze the relationships between humans and the earth's resources.

A. Indicators of Learning

(1) The student will evaluate the interrelationship between humans and air quality.

At least —

- ozone
- greenhouse gases
- volatile organic compounds (smog)
- acid rain
- indoor air
- human health

(2) The student will evaluate the interrelationship between humans and water quality and quantity.

At least —

- fresh water supply
- point source/nonpoint source pollution
- waste water treatment
- thermal pollution
- Chesapeake Bay and its watershed
- eutrophication
- human health

(3) The student will evaluate the interrelationship between humans and land resources.

At least —

- wetlands

- soil conservation
- mining
- solid waste management
- land use planning
- human health

(4) The student will evaluate the interrelationship between humans and biological resources.

At least —

- food production/agriculture
- forest and wildlife resources
- species diversity/genetic resources
- integrated pest management
- human health

(5) The student will evaluate the interrelationship between humans and energy resources.

At least —

- renewable
- nonrenewable
- human health

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

Rainwater is collected over a period of months to determine the varying amounts of acid present. Students use pH probes and CBL's to analyze the rainwater and organize the data. The data is displayed on spreadsheets which include the source of rain, the amount of rain, the time of day, and track of the storm. Students obtain regional data from the internet to determine the average pH of rainwater. Levels of acid that are toxic to organisms are identified. Methods of neutralization are investigated including filtering rainwater through soil from their yard, using prepared lime, and natural buffering using limestone.

4. Expectation: The student will develop and apply knowledge and skills gained from an environmental issue investigation to an action project which protects and sustains the environment.

A. Indicators of Learning

(1) Identify an environmental issue and formulate related research questions.

Methods of gathering information may include

- writing letters
- performing a literature search
- using the internet
- interviewing experts

(2) Design and conduct the research.

Methods of data collection may include

- field or laboratory
- questionnaire/opinionnaire

(3) Interpret the findings to draw conclusions and make recommendations to help resolve the issue.

(4) Apply the conclusions to develop and implement an action project.

Methods of implementation may include

- physical action
- persuasion
- consumer action
- political action

(5) Analyze the effectiveness of the action project in terms of achieving the desired outcomes.

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

Students work in teams to research a microorganism which has been found to be toxic to certain fish in the Chesapeake Bay ecosystem. To better understand the habitat and niche of the organism, background research is conducted using the internet. Surveys are conducted in the community to obtain information as to the public's knowledge and misconceptions regarding the microorganism. The group analyzes their research to determine possible courses of action. The students perform water testing at aquatic sites where the microorganism has been observed. The students also write letters and meet with political and environmental officials to broaden their perspectives of the impact of this microorganism on their community and the state of Maryland. They compile the data using computer spreadsheets and graphs which are then presented to the class. The results are discussed in class and the group meets again to modify or confirm their course of action. A decision is made to continue the water monitoring on a regular basis to determine if there is a correlation between nutrient levels and the occurrence of the microorganism. The students discover a correlation after three additional months of water testing and advise local officials by sharing their data and making written recommendations for improving the bay ecosystem.