Student Performance Q&A:

2002 AP® Environmental Science Free-Response Questions

The following comments are provided by the Chief Reader regarding the 2002 free-response questions for AP Environmental Science. *They are intended to assist AP workshop consultants as they develop training sessions to help teachers better prepare their students for the AP Exams*. They give an overview of each question and its performance, including typical student errors. General comments regarding the skills and content that students frequently have the most problems with are included. Some suggestions for improving student performance in these areas are also included. Consultants are encouraged to use their expertise to create strategies for teachers to improve student performance in specific areas.

Question 1

What was intended by the question?

This question required students to assess the environmental implications of using electric vehicles as an alternative to gasoline engines for transportation. Students had to demonstrate a clear knowledge and understanding of two environmental benefits associated with using electric vehicles in place of gasoline vehicles. Based on the supplied data, the students had to estimate the yearly reduction in gasoline consumption assuming electric vehicles replaced 10 percent of the gasoline-powered cars in the United States. Students were asked to explain a statement relating to a point of contention regarding a shift in the emission of air pollutants with respect to electric vehicles. They were expected to identify gasoline vehicles as being a dispersed source, and an electrical generating power plant as a point source of air pollutants. An argument to defend the statement would identify the electrical generating power plant as using a combustion source and hence creating air pollution. An argument to refute the statement would identify the electrical generating power plant as using a non-air polluting energy source. Students were asked to propose, and explain, two new United States government policies that would result in increased use of electric vehicles.

How well did students perform?

A common answer for an environmental benefit associated with using electric vehicles was the identification of decreased levels of carbon dioxide emissions leading to less global warming effects. Many students correctly identified lower levels of carbon monoxide emissions from the use of electric vehicles, with a fewer number being able to correctly identify a specific environmental benefit. Another common answer was that with a reduction in gasoline vehicles there would be a reduced need for drilling new oil wells, which would result in less habitat destruction. A smaller number of students identified and described the environmental benefits of reduced emissions of nitrogen oxides and the resulting decrease in acid precipitation. Many students were able to correctly estimate the reduction in petroleum consumption as being six billion gallons of gasoline per year, but a smaller number received credit for correctly setting-up the calculation. Some students did not set up the calculation in the form of an equation, but

attained credit for a well-written analysis. Few students were able to recognize the gasoline-powered vehicles as being a dispersed source and the electrical generating power plant as a point source of air pollution. Some were able to defend or refute the statement by referring to the amount of air pollution from the specific energy source that is used in producing the electricity to power the electric vehicles. Many students were able to propose at least one viable policy that would result in increased use of electric vehicles. A tax incentive relating to owning an electric vehicle was a popular answer.

What were common errors or omissions?

A high number of students were not specific enough in their identification and descriptions of the environmental benefits of using electric vehicles. Some did not go beyond a statement such as "less air pollution," or "less harmful emissions." Others mentioned "less use of fossil fuel," without further explanation, or cited "less dependence on foreign oil" as an environmental benefit. Another common misconception was that carbon monoxide caused acid rain, global warming, or depleted the stratospheric ozone layer. Many students incorrectly discussed ozone levels with reference to the "hole in the ozone layer," rather than the buildup of ground level ozone as a secondary pollutant. Indeed, some students simply stated, "car emissions cause ozone depletion." Confusion was also noted in some answers suggesting "smog came directly out of the tailpipe of cars," or that "carbon dioxide causes smog." In some cases, students incorrectly referred to hybrid vehicles rather than electric vehicles, or even confused these two types of vehicles. A major oversight in the straightforward calculation was the omission of units, and errors in the setup, for example, multiplying ten thousand (miles per year) by twenty-five (miles per gallon) instead of dividing. Other students set the equations up correctly, including units, but made errors in the simple calculation, often using too few or too many zeros in their answers. A common mistake occurred in the identification of the dispersed and point sources of air pollution. Many students referred to the factory that manufactures the electric vehicles rather than the electrical generating power plant as being the point source of air pollution. Some students discussed point and non-point pollution in relation to agricultural run-off and sewer pipe effluent. Other students discussed the ease of controlling the emissions from a point source, such as adding scrubbers to smokestacks, without actually answering the question. A common misconception was evidenced in many student suggestions that the government could directly increase or decrease either the cost of cars, or car insurance rates. Other students stated a policy but failed to elaborate as to how it would result in increased electrical vehicle use.

Based on your experience at the AP Reading, what message would you like to send to teachers that could improve the performance of their students on the exam?

Make sure that students understand that no points are given for simply restating the question. Have students organize their answer into parts (a), (b), (c), and (d), clearly labeling each section. Practice math calculations to ensure the correct setup, the use of scientific notation, and the inclusion of all units. Demonstrate how canceling units can be an added check to confirm the correct answer. It is imperative that ALL work is shown for a calculation, and ALL units MUST be included, in the answer book. From the student answers to the above question, it is apparent that more attention must be given to the difference between tropospheric and stratospheric ozone, point sources and disperse sources of air pollution, and the specific types of emitted air pollutants and their environmental consequences. Emphasize the need for students to focus on answering the question being asked, stick to the point, and pay attention to produce a concise yet detailed response, avoiding the use of generic or 'catch' phrases, such as "less pollution" and "environmental degradation."

Question 2

What was intended by the question?

The intent of the question was to have students perform three tasks involving the topic of water diversion: 1) describe and discuss two environmental problems associated with water diversion, 2) make an argument for the diversion of water for urban consumption, and an additional argument for permitting water to flow to natural areas, and 3) identify one example of a large-scale water diversion project (the water diversions which are located on the Colorado River could not be used.) Part (c) was intended to focus on a fairly small number of large-scale projects, such as the Aswan Dam on the Nile River in Egypt, the Three Gorges Dam on the Yangtze River in China, the shrinking Aral Sea, and the James Bay Project in Quebec. The question in part (c) informs students that the water diversion project that they identify must be "other than the Colorado River." Many students may have used this directive as a model in deciding how they would phrase/identify their project.

Responses to this identification portion of part (c) were frequently phrased simply as "the Amazon River," or "the Mississippi River." Due to the phrasing of the question, answers in this form earned the 1 point for this part of (c), although the question was not written to incorporate the thousands of potential dams, levees, reservoirs, and other diversion projects around the globe.

How well did students perform?

Most students were able to earn at least 1 or 2 points somewhere in the three parts of this question. The three parts provided students with opportunities to discuss information involving three major, interconnected areas involving water: associated environmental problems, urban consumption and the flow of water to natural areas, and other examples or case studies of water diversion.

What were common errors or omissions?

Some students gave very general statements instead of a comprehensive description or discussion in parts (a) and (c). In part (b), students were asked to make two arguments, one for the diversion of water for urban consumption and one for permitting the flow of water to natural areas. Many students provided one piece of information, perhaps thinking they were limited to a single supporting statement, when they could have provided a coherent series of statements directed at solidifying the argument for each side. Students are encouraged to write thorough and specific responses as opposed to making vague statements. Students should also note the use and meaning of "environmental," as in "environmental problems" in parts (a) and (c). Many students provided "economic" problems or issues, which were not included in these two parts of the question.

Based on your experience at the AP Reading, what message would you like to send to teachers that could improve the performance of their students on the exam?

Free-response answers should be as comprehensive and complete as time allows. Naming and listing is not sufficient when the question asks for a description, discussion, or argument.

Question 3

What was intended by the question?

This question was intended to test students' ability to plot toxicity test data (experimental data) on a semi-log graph, to define and then interpret basic terminology using their graph, and to prepare two arguments regarding the application of this toxicity test to humans.

How well did students perform?

Most of the students could plot the data points and many could also draw a smooth curve. Beyond the graphing, students were generally better at stating definitions or locating specific points on the graph than they were at developing arguments.

What were common errors or omissions?

In their drawing of the smooth curve, some students attempted to draw a line of best fit; others connected the data points with straight lines and still others were simply careless. Common errors included the inability to read a semi-log graph (for example 0.07 was read as 0.016). LD50 was mistakenly applied to entire populations or species and also linked with causing extinction. Some students confused LD50 and Threshold Level; there was also some confusion between Threshold and Threshold Level. Many students had difficulty locating the Threshold Level-some thought it was at 0.1 percent (the halfway point on the exponential curve) or at 10 percent when all the brine shrimp were dead. Some students indicated that they had no idea what LD50 or Threshold Level of Toxicity meant. "Extending these toxicity results to humans" was interpreted as "extending this testing to humans" and resulted in flawed arguments with respect to the question. This was also interpreted as meaning "informing the public," which resulted in inappropriate arguments. Several students confused brine shrimp with edible shrimp. Students also seemed to have difficulty developing a coherent argument.

Based on your experience at the AP Reading, what message would you like to send to teachers that could improve the performance of their students on the exam?

Students definitely need practice in reading the questions more carefully and understanding what is expected in the response. They also should have more experience with laboratory work in terms of data, data analysis, graphs (different types), and graph interpretation. This particular experiment is included in the list of suggested laboratory activities in the Course Description for AP Environmental Science — within their course of study, teachers should include as many of these labs as possible and discuss them using topic-specific terminology. Additionally, whether the students generate the graphs manually or by computer, they should know how to read and interpret them.

Students also need practice in developing concise arguments. Starting with a premise or thesis statement they should be able to succinctly include supporting details that lead to a conclusion. Part (d) of this question specifically required students to draw upon their knowledge of experimental design, toxicity testing and associated variables, dose-response relationships, mathematical interpretation of data, the chemistry of $CuSO_4$, the biology and ecology of brine shrimp and humans, and the legal and ethical issues associated with laboratory testing involving animals. Students should be able to apply their background knowledge to support and/or refute a statement.

Question 4

What was intended by the question?

The primary purpose of this document-based question was to assess students' ability to assimilate and synthesize information given in the article; draw logical conclusions based on the information in the document and their own knowledge; and clearly give arguments of cause and effect of specific climate change.

How well did students perform?

In general, student performance on this question was poor.

What were common errors or omissions?

In part (a), one of the most common errors was an incorrect or too broad an identification of the region in which El Niño occurs. Many students indicated that El Niño occurs in the Atlantic or Indian Oceans. Other common answers were the Pacific Ocean, the coast of South America, the South Pacific, or the coast of North America (these areas may be affected, but are not an accurate description of where the primary phenomenon is taking place). A significant number of students did not address the location portion of this question at all.

Another relatively common problem in this section was an incomplete definition of El Niño from the document. Students should take care to pull all relevant information from a document when answering a question.

In part (b), the most common omission was that of specifying what climate change associated with El Niño would increase disease transmission. Simply using the word "change" or the phrase "suitable temperature/climate" is too vague. Students who knew little or nothing about El Niño but read the document carefully should have been able to use key words and phrases like "cholera," "yellow fever," or "vector-transmitted disease" to work backwards and figure out what types of climate change would be conducive to increasing mosquito populations or for growth of cholera-causing bacteria.

Lack of understanding of modes of disease transmission was common. That is, many students did not appear to understand that disease transmission could occur through mechanisms other than vector-borne. Many students realized that the mosquito is a vector for disease, but did not realize that cholera is caused by bacteria and is not typically carried in insects.

A significant number of students did not explain why they believed the article to be correct or incorrect. It was insufficient to simply write, "I think the article is correct."

The primary problem in part (c) was that students tended to be too general in their answers (e.g., Africa, Asia). Students should be able to clearly justify any answer they give.

The most common error in part (d) was failure to link the environmental problems that they chose to discuss with ENSO. Many students incorrectly stated that ENSO events cause or increase global warming, or cited economic rather than environmental problems.

Based on your experience at the AP Reading, what message would you like to send to teachers that could improve the performance of their students on the exam?

In a document-based question, students should be able to read and assess the information contained in the document. There are often clues within the document itself to guide the student in answering the questions (e.g., vector-borne diseases). When a question includes reference to a specific event, students should make sure that their answer is clearly connected to that event, and explicitly state this connection in their answer. For example, in Part (d) when students are asked for environmental problems associated with ENSOs, they should clearly state how the environmental problems they choose to write about are associated with ENSO. Many students ignored the last part of the question, and simply discussed generic environmental problems without any reference to how or why these problems may occur in relationship to change brought about by ENSO events.