Student Performance Q&A:

2003 AP® Environmental Science Free-Response Questions

The following comments on the 2003 free-response questions for AP® Environmental Science were written by the Chief Reader, Thomas Mowbray of Salem College in Winston-Salem, North Carolina. They give an overview of each free-response question and of how students performed on the question, 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 provided. Teachers are encouraged to attend a College Board workshop, to learn strategies for improving student performance in specific areas.

Question 1

What was the intent of this question?

This question was based on an article about the discovery of an invasive species (an Asian worm) in a deciduous forest. The question was intended to test students' knowledge of several fundamental ecological processes as well as students' ability to apply that knowledge in the context of the ecological problem described in the article. The question also tested students' skills in designing a controlled experiment to determine how the worms might be changing the forest ecosystem.

How well did students perform on this question?

Students were generally able to earn at least one of the points in Part (a) and, if they recognized the question was asking for an *abiotic* change, another point in Part (b). Many students were unable to take one of the abiotic changes they described in Part (b) and explain how that specific change could set the stage for the takeover of the Japanese stilt grass or other exotic species. Part (d) proved challenging to the majority of students, with many unable to earn any points. The mean score for this question was 3.33 out of a possible 10 points.

What were common student errors or omissions?

In Part (a) the most common error was not including at least one role of leaf litter that is tied to plants and/or giving only one role. In Part (b) the most common error was to describe biotic changes rather than abiotic changes that would be likely to result if the exotic worms consumed all the leaf litter in a single year. It was very common for students to describe changes in biodiversity, such as loss of particular plants and animals.

The most common error in Part (c) was linked with Part (b) in assuming that all the native plants would die and, as a result, there would be more open space. Many students stated that open space alone was the reason for the invasion of an exotic species. From student responses, it was clear that many were unable to distinguish the reason an exotic rather than an indigenous species would be able to colonize an area.

In Part (d) the most common error was the lack of organization and specificity in the design of an experiment. Many student responses lacked a specific and testable hypothesis; for example, "test for nutrients" did not earn a point. Students often did not narrow down the hypothesis or the data collection to realistic targets, such as measuring soil nitrogen levels. Frequently, they did not identify the source of the data. Although students sometimes knew that more than one area or "plot of land" would be necessary, they often did not provide sufficient specificity to earn the protocol point that could be earned for the inclusion of control group(s), experimental group(s), *and* either a specific time or a specific area, or specific materials, or a specific sample size. It seems clear that many students did have some familiarity with a hypothesis statement, a control group, and an experimental group, but most showed poor understanding of what a specific testable hypothesis is and how to properly connect that functional hypothesis with an experiment that could actually be carried out.

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

Teachers are encouraged to provide as many experimental design activities as possible for their students throughout the academic year. These activities should include hypothesis development, designing experimental protocol, observation, and analysis.

Teachers are also encouraged to continue emphasizing the need for specificity, detail, and completeness in their students' answers. Specificity and detail should not be confused with regurgitation of "factoid"-like information; rather, it should be treated as an essential part of the comprehensive understanding of concepts and processes expected in a college-level course. Teachers should constantly remind their students that responses that are too vague and general in nature do not earn points on the exam.

Question 2

What was the intent of this question?

The primary purpose of this data-based question was to assess students' ability to 1) synthesize data provided in the question and appropriately construct a line graph from those data, 2) perform basic algebraic computations to solve equations, 3) provide logical explanations for the data on the basis of their understanding of the concept of demographic transition, and 4), given certain variables, recognize and correctly apply one of several equations that could be used to determine the future size of a population.

How well did students perform on this question?

Overall, student performance was fair. Given the basic graphing that was required and the relatively simple computations that could be used to answer parts of the question, better responses were expected. The mean score for this question was 3.1 out of a possible 10 points.

What were common student errors or omissions?

In Part (a) many students showed evidence that they did not know how to construct a simple line graph according to the directions. The task required first labeling the axes (with the units of measure provided), then correctly plotting the data provided in the question, and lastly constructing a line graph from the plotted data points. Many used inconsistent scaling, such as representing the distance between 2 grid lines as 10 years on one part of the axis and either less or more than 10 years on another part. Many either did not label the axes or labeled the axes inappropriately. Often, students neglected to plot certain data points and, in general, were inaccurate in constructing the graph. Many erred by starting their curves at the origin (both coordinates 0).

In Part (b) many students lost points because they did not show their work. Some students also had difficulty in recognizing which data from the question were appropriate to use in finding the answer. Simple math errors were common.

Students often did not answer the question in Part (c) as requested. Many wrote a substantial amount but failed to account for the rapid decline in death rate, or the high birth rate in 1855, or the slow decline in birth rate between 1855 and 1950. Students frequently provided partial answers or answers that contradicted the information given in the question.

In Part (d) the most common error was failure to recognize that the "Rule of 70" applied and could have been used in a simple calculation to arrive at the answer. It was common for students to attempting to use another equation (from math or economics) to arrive at the answer, only to find that complex, advanced methods requiring a scientific calculator were involved.

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

The ability to graph and interpret data is essential when studying environmental science. To develop this ability students must 1) practice with data they collect themselves and with data provided to them, 2) create tables to organize the data, and 3) construct a variety of graphs, such as line graphs (with the independent variable plotted on the horizontal axis and dependent variable plotted on the vertical axis), bar graphs, pie charts, and others. While many computer programs can be used as an aid, students must still be able to extract data provided in narrative format and organize the data to be displayed as a graph.

Students should show *all* the steps of their work in order to maximize the possibility of earning points. Correct answers with no justifying work earn no credit.

Regarding the subject of the demographic transition, it is important for students to understand not only the factors involved in lowering the death rate but also the factors that cause a lowered birth rate to lag behind.

Question 3

What was the intent of this question?

The intent of this question was to test students' ability to 1) determine cause and effect relationships involved in patterns of variation in coastal estuaries, 2) discuss coastal wetlands in terms of their ecological and economic importance, 3) identify and explain the negative impacts of human activities on coastal wetlands, and 4) explain how the negative impacts of human activity could have been prevented or lessened through an environmental policy and through an economic incentive.

How well did students perform on this question?

Overall, student performance on this question was poor. Many students could correctly identify "causes," "roles," or "ways" but did not discuss or explain them, thereby failing to earn points. The mean score for this question was 2.64 out of a possible 10 points.

What were common student errors or omissions?

In Part (a) students could generally identify two important causes of seasonal and/or hourly variation in salinity and/or temperature. Since both identification and connection were required to earn one point for each cause, many students did not earn points because their responses either lacked a connection or included an incomplete or incorrect explanation of the connection. A feature common to many responses was that there was no indication of the direction of the temperature and/or salinity change under various environmental conditions. Some students interjected negative human impacts as an important *cause* of the hourly or seasonal variations in temperature or salinity. These responses were appropriate for Part (c) but earned no credit for Part (a).

In Part (b) many students could identify important ecological roles, but they did not adequately discuss these roles beyond some simple "buzz" terms. Students did perform better on identifying and explaining economic roles, but many did not discuss appropriate agricultural products of wetlands.

In Part (c) students tended to list human activities that had negative impacts on coastal wetlands, but they did not follow through and explain the negative impacts. Since the question requires both identification and explanation, students often did not earn points because their responses either lacked an explanation, included an inappropriate explanation, or simply copied the phrase "degraded coastal wetlands" from the question. Many responses did not link specific pollution activities with explanations of their negative impacts, and they were too vague to earn points. Some students included more than three impacts in their response; as explained in the directions on the back cover of the exam booklet, only the first three were scored. So, if the first impact was incorrect and the next three were correct, only two points were earned.

In Part (d) students were generally able to explain an environmental policy and an economic incentive as they related to the negative impact from Part (c). Some students cited a specific environmental law and explained how it could have prevented the referenced negative impact. Citing a law was not required by the question. Therefore, if a student failed to correctly describe the provisions of the law but went on to explain an appropriate policy that could have prevented the negative impact, then a point was earned. Most students were also able to earn a point by explaining an applicable economic incentive; some described disincentives that would serve to discourage the negative impact and also earned the point.

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

Students must be encouraged to read the question carefully; a simple listing of terms or phrases is not a substitute for explanations or descriptions. Likewise, if asked to describe three impacts, students should focus on organizing the best response for those three impacts and not expend time and effort on additional examples. Additionally, students need practice in writing explanations and discussions that include general concepts and specific supporting details and topic-specific terminology. When students' responses are vague and lack the specificity required by the question, points are not earned.

Question 4

What was the intent of this question?

The purposes of this question were threefold: to assess students' ability to 1) distinguish between natural and anthropogenic causes for the decline in populations of different species, 2) examine the causes of species endangerment and the remediation of the problem, and 3) develop an argument both for and against a particular position on a topic in environmental science.

How well did students perform on this question?

Overall, student performance was weak on this question, primarily because students failed to develop their ideas into descriptions or arguments. Many students who lacked familiarity with the two example species in the first two parts of the question were not able make inferences based on the species with which they were familiar. The mean score for this question was 2.39 out of a possible 10 points.

What were common student errors or omissions?

Part (a) required the most specific knowledge, and the best answers showed that the students knew something about the two species. Most attributed the decline to very recent problems, such as pesticides and other purely anthropogenic causes, not understanding that the birds had been reduced to a dangerously low population size before modern human impacts added to the downward trend in population size. Students had more success discussing the whooping crane, though again many did not explain the impact of fixed migration patterns combined with the loss of wetland habitat, and they focused instead on more recent problems like DDT and power lines. Students who vaguely mentioned habitat loss earned no points unless they described the specific type of habitat loss and how it would cause the population to decline.

In Part (b) many students earned points for more general knowledge by citing provisions of the Endangered Species Act (ESA). Because the question asked for a *description* of the measures taken, some students earned no credit for simply naming the ESA or similar legislation. Sometimes, students neglected to specify which species benefited from each measure, as required by the question. An elaboration point was available for students to earn if they knew of specific strategies used to reestablish the California condor or whooping crane. Relatively few earned this point; it was possible to earn a full score of 10 on the question without it.

Parts (c) and (d) together gave students who knew nothing about the California condor or whooping crane an opportunity to earn six points. In Part (c) most students could name characteristics of endangered species that would cause them to be slow to recover, but many did not describe the characteristic or link the characteristic to the slow recovery of the population. A common error in Part (d) was neglecting to identify an endangered species. Many students named a type of organism (e.g., orchid) without naming a specific endangered species. However, the real challenge in this part of the question was the development of arguments for and against the protection of a particular species. An argument is a "coherent series of statements leading from a premise to a conclusion;" thus, students needed to develop an answer that went beyond a single statement in order to earn the point. It was not uncommon for students to earn one point by stating an idea and giving a supporting statement, but then neglect to further develop their argument. Often a list of unrelated examples was given as an argument instead of developing a single argument.

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

Students must cover the topic of general causes of species endangerment/extinction in the course, and they should learn that not all causes of extinction are related to human actions.

Teachers must emphasize the idea that a description, a discussion, or an argument implies more than a list of ideas. Students need practice in answering questions using these different terms.

Students should be reminded that if a question asks for *two* factors, taking a "scattershot" approach will be of no help unless their first two answers are the particular ones they would like readers to score.

Finally, it should be communicated to students that specificity is almost always good. Students should understand that a kind of animal (e.g., a frog) is not the same thing as a species of animal (e.g., not all species of frog are endangered).