Environmental Science| 2017-2018 Assessment Report

1. Please give a brief overview of the assessment data you collected this year.

There are six student learning outcomes for the Environmental Science program. In the past four years, we have assessed outcomes 1,3,4,and 5, leaving 2 and 6 to be assessed. **I decided to evaluate Environmental Science Outcome 2 this year: Recognize relationships between humans and ecosystems at local, regional, and global scales.**

Env Sci Outcome 1: Understand fundamental physical and biological processes of the natural environment. Fermanich/Zorn (Fall of 2015)

Env Sci Outcome 2: Recognize relationships between humans and ecosystems at local, regional, and global scales.Draney Env Sci 102 (climate change) (Spring 2018)

Env Sci Outcome 3: Apply knowledge from multiple disciplines to environmental challenges and opportunities. Terry embedded in Env Sci 305; Spring 2017)

Env Sci Outcome 4: Build practical skills for scientific problem-solving, including familiarity with laboratory and field instrumentation, ability to use current computer technologies, and experience in statistical modeling techniques. DAVIS (Spring of 2014)

Env Sci Outcome 5: Demonstrate competency in collecting, managing, evaluating, interpreting, and communicating information through hands-on research. WOLF (Spring of 2015)

Env Sci Outcome 6: Critically evaluate strategies for sustainable management and restoration of environmental systems.

I conducted an embedded assessment of **Env Sci 102, Introduction to Environmental Science.** This is a general education course, but it is also a required class for Environmental Science minors. The final exam in this course covered **Energy, Air Pollution, and Global Climate Change** this year, and I thought these topics were a perfect example of Outcome 2, the relationships between humans and ecosystems at local, regional, and global scales.

The exam consists of an individual and a group portion. Here I will analyze only the individual portion, which counts for 60% of the students' exam grade. It consists of 30 multiple choice questions, each worth 2 points, for 60 of the 100 exam points.

Performance rating scale is simply a translation of the course grading scale.

90% or more correct = **Outstanding**. Students have a good understanding of how our energy systems effect ecosystems via air pollution and climate forcings.

80% or more correct = **Good**. Students demonstrate reasonable understanding of much of the material, but there are gaps or weaknesses in the student ability to apply this knowledge.

70% or more correct = **Marginal**. Students display some useful knowledge of the relationship between our energy systems and air and climate, but there are significant gaps in this understanding.

Less than 70% correct = **Unacceptable**. Students' understanding of the topic does not meet the instructor expectation for level of comprehension and ability to apply the knowledge.

Note: This is a very conservative analysis, in that the instructor curves the exam results considerably (with the understanding that the questions do not perfectly test student comprehension, and so need to be corrected for a fair evaluation). However, this assessment of learning objectives is being done on raw scores, which are lower than the exam scores received by the class.

The Evaluation Questions. Correct Answers are highlighted, and percent of class getting the answer correct is listed in parentheses.

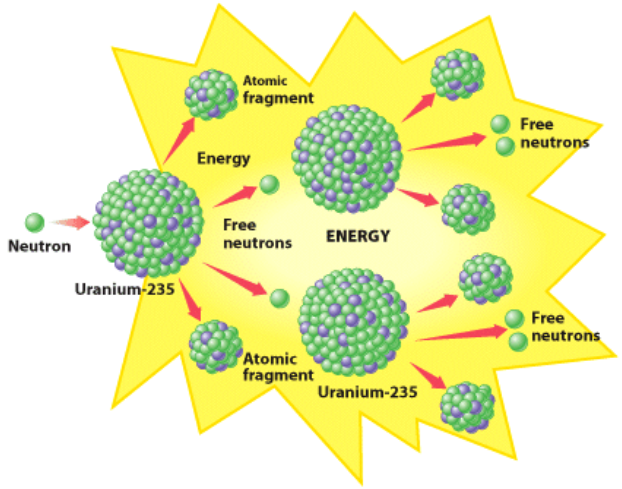
1. Which of the following is **NOT** a renewable source of energy? (**94%** of students got this correct)
   - A) wind
   - B) fossil fuels
   - C) direct solar
   - D) biomass
   - E) hydropower

2. What is cogeneration? **(77%)**
   - A) A technology that developed over two generations.
   - B) A way of recycling heat that is produced as a by-product of electricity generation.
   - C) An energy type responsible for increasing the energy efficiency of the Oswego power plant by nearly three-fold.
   - D) An energy type not presently feasible in small settings; instead cogeneration is only used in large projects.
   - E) A technology that involves the use of 175 - 200°F exhaust gases.

3. Why is wind energy considered a form of **indirect** solar energy? **(77%)**
   - A) Wind energy is used to heat water to generate electricity.
   - B) Winds are caused by the solar warming of air.
   - C) Wind is older than any other type of fuel.
   - D) Like solar, wind produces very few types of pollution.

4. Which of these fossil fuels is composed primarily of methane? **(69%)**
   - A) oil
   - B) natural gas
   - C) coal
   - D) tar sands
   - E) lignite

5. What does the diagram below illustrate? **(75%)**



A) nuclear enrichment
B) nuclear fission
C) nuclear fusion
D) infrared radiation

6. Which energy technology is currently best described as "an expensive and risky way to boil water"? **(37%)**
A) Nuclear fusion.
B) Nuclear fission.
C) Solar thermal.
D) Compressed Air Energy Storage.

7. What is the main difference between passive and active solar? **(52%)**
A) Active solar requires pumps and fans to distribute heat.
B) Passive solar requires pumps and fans to distribute heat.
C) Passive solar requires liquid to store accumulated heat.
D) Passive solar is only effective in the southwestern United States.
E) Passive solar can be used in higher latitudes than active solar.

8. What sustainable energy project is being developed on a Wrightstown, WI dairy farm? **(76%)**
A) Feeding gasohol corn waste to dairy cows.
B) Use of building-integrated photovoltaics (BIPV) on farm buildings.
C) Production of methane from anaerobic breakdown of cow manure.
D) Harvesting of methane from cow flatulence.

9. Why is much natural gas found during oil drilling "flared"? **(44%)**
A) Flaring removes impurities.
B) Flaring prevents the addition of carbon dioxide to the atmosphere.
C) Flaring prevents the addition of methane to the atmosphere.
D) Natural gas found with oil contains high levels of impurities, and is too expensive to clean.
E) Flaring makes extracting the oil cheaper, and the oil is worth a lot more than the natural gas.

10. Fracking is used to extract _____, and the technology is often used in conjunction with _____. **(73%)**

A) oil and gas; horizontal drilling
B) tar sands and oil shale; horizontal drilling
C) oil and gas; mountaintop removal mining
D) tar sands and oil shale; mountaintop removal mining

11. The Clean Air Act has had the most success dealing with _____ pollution; _____ pollution is more difficult to regulate. (71%)
A) primary; secondary
B) secondary; primary
C) point source; nonpoint source
D) nonpoint source; point source

12. _____Ozone is a pollutant that harms plants and animals, whereas _____ ozone is necessary for plant and animal life to exist. (57%)
A) stratospheric; tropospheric
B) tropospheric; stratospheric
C) oxidized; reduced
D) reduced; oxidized

13. What is the main source of the indoor air pollutant radon? (51%)
A) The burning of wood and dung for cooking fires.
B) Natural emissions seeping into building foundations from the ground.
C) Cigarette smoking.
D) Carpeting, fabrics, and furniture.
E) The burning of coal for heating.

14. What type of cancer is expected to increase due to ozone depletion in the upper atmosphere? (78%)
A) lung
B) liver
C) brain
D) skin
E) pancreatic

15. Why is a layer of ozone high in the atmosphere so important? (76%)
A) Ozone breaks down greenhouse gases.
B) Ozone shields the earth from infrared radiation.
C) Ozone contributes to albedo, which cools the earth.
D) Ozone prevents the melting of the polar ice caps.
E) Ozone shields the earth from ultraviolet radiation.

16. In terms of effects on human health, the #1 air pollution problem in the United States is probably
A) ozone and other photochemical oxidants. (83%)
B) volatile organic compounds (VOC's).
C) smoking.
D) sick building syndrome.

17. Point sources of pollution, such as _____, are _____ than non-point sources. (74%)
A) power plants and factories, easier to regulate

B) power plants and factories, more difficult to regulate
C) small farms and automobiles, easier to regulate
D) small farms and automobiles, more difficult to regulate

18. A nation that could conceivably "disappear" as a result of global warming is **(73%)**
A) Madagascar
B) The Maldives
C) Malawi
D) Malabar
E) Moldova

19. How is global warming expected to affect water levels in the Great Lakes? **(53%)**
A) Lake levels will fall mostly due to greatly increased summer evaporation.
B) Lake levels will fall mostly due to greatly increased winter evaporation.
C) Lake levels will rise mostly due to increased levels of regional precipitation.
D) Lake levels will rise mostly due to greatly decreased summer evaporation.
E) Lake levels will rise mostly due to greatly decreased winter evaporation.

20. Which of the following greenhouse gases has no natural source? **(69%)**
A) carbon dioxide(CO_2)
B) methane(CH_4)
C) nitrous oxide(N_2O)
D) chlorofluorocarbons(CFC's)
E) ozone (O_3)

21. Which of the following activities is responsible for the largest percentage of human-made carbon dioxide emissions? **(77%)**
A) Burning fossil fuels
B) Deforestation
C) Ozone depletion
D) Acid deposition
E) Agriculture

22. How might global warming have doomed Costa Rica's golden toad? **(58%)**
A) The toad could not adapt to the warmer and drier conditions.
B) The toad could not travel to cooler climates, because it already inhabited the tops of the mountains.
C) Roads built for ecotourism prevented the toad from migrating to cooler regions.
D) Warmer and cloudier nights allowed an invasive fungus to spread.

23. Which greenhouse gas has the most heat absorbing ability on a per-molecule basis? **(32%)**
A) carbon dioxide (CO_2)
B) chlorofluorocarbons (CFC's)
C) methane (CH_4)
D) nitrous oxide (N_2O)
E) water vapor (H_2O)

24. Albedo is a term describing the Earth's **(58%)**

A) reflection of solar radiation.
B) refraction of energy.
C) production of radiant heat.
D) use of energy in biomass production.

25. Water vapor is the most _____ greenhouse gas. (71%)
A) abundant
B) important
C) permanent
D) powerful

26. Carbon dioxide is the most _____ greenhouse gas. (34%)
A) abundant
B) important
C) permanent
D) powerful

27. Most climate change models predict that in the coming century, Wisconsin's climate will become (66%)
A) warmer and drier.
B) warmer and wetter.
C) cooler and drier.
D) cooler and wetter.

28. _____ is now the #1 emitter of greenhouse gases, but _____ remains the #1 *per capita* emitter. (68%)
A) Japan, The United States
B) The United States, Japan
C) China, The United States
D) The United States, China

29. Why is it more difficult for organisms to move in response to climate change today than it was during and after the last ice age? (89%)
A) Human-created habitat fragmentation and barriers make long-distance movement more problematic.
B) It is easier to disperse across ice and snow than across snow-free terrain.
C) Decrease in stratospheric ozone has made long-distance movement more dangerous.
D) Changes in wind patterns and ocean currents no longer facilitate the natural migration patterns.

30. Why is the main reason why global climate change is currently threatening polar bears?
A) Polar bears are drowning in melting permafrost. (59%)
B) The sea ice that bears need to hunt seals is available for a shorter time during most years.
C) Polar bears cannot tolerate warm temperatures.
D) Populations of polar bears' main food, seals, are threatened by ocean warming.
E) Population of polar bears' main food, seals, are threatened by ocean acidification.

Results: On average, 66% of students answered a given question correctly.

The class percentages ranged from 33 to 97, the class mean was 65.67 and the median was 63. The standard deviation was 14.58.

Performance Rating	Number of Students	Percent of Class
Outstanding = 1	6	6
Good = 2	17	17
Marginal = 3	19	19
Unacceptable = 4	58	58

The average performance rating for the class was 3.29, which is "marginal".

2. How will you use what you've learned from the data that was collected?

The results are not surprising to the instructor. This is a science class that some STEM students and many non STEM students take, and the level of science preparation of the students, on average, is not high. As expected, a minority of students did very well and show that they understand the material very well, but a majority of the class has what we in our program would deem an unacceptable level of understanding of the concepts after taking the course.

There are a few possible explanations for this result, and probably several partial explanations are acting. One factor is that there are two student populations in this course: It is a general education course that many non-majors take, but it is also required of Environmental Science minors. The instructor has to find a balance in rigor such that well prepared students learn in the class but less prepared students may still pass the course. It could be argued that the course is being taught at too high a level for the average student to master the material, but on the other hand, that is the purpose of curving the scores.

Class size also is probably a factor. There were over 100 students enrolled in this course section, so the main means of evaluation was multiple choice questions, which many students have trouble with, and which students and professionals often argue do not adequately reflect actual student learning.

In order to compensate for both of these potential problems, the instructor introduced a group exam portion this semester. The students complete the multiple choice exam portion shown above during the first part of the exam period, and that is worth 60% of the student's grade. But 40% of the student's grade is based on a group exam, where groups of 4 or 5 students work together to answer 30 points worth of multiple choice questions (some are repeats of individual questions, and some are new and often more challenging questions), and also short answer/short essay questions worth 10 points. This accomplishes two things: 1) It raises the grades of less prepared students and allows a higher percentage of students to pass this course, and 2) It allows the students to be evaluated on written questions….the instructor has to grade fewer than 25 rather than more than 100 such essays. Another benefit is that it gives the students both opportunity and motivation to discuss material together, and solve problems together. Not all students appreciate the group portion, but many do, and the instructor thinks it worked well.

Besides changing pedagogy and limiting class size (which really isn't an option given our resource challenges), another possible solution is curriculum change. We could possibly have two courses, one for environmental science minors and one strictly for general education, only for non majors. I foresee two issues with this

solution, one being that it would also take more instructor resources, and another being that this instructor already feels the material should not be taught in a less rigorous way. Thus, the pedagogy and delivery methods remain the most viable options for improving class performance. The instructor plans to work on that, although the instructor has been working on that in this course since 1999.

These results (and possible responses to them) will be discussed at an NAS faculty meeting in Fall 2018.