SCIENTIFIC LITERACY: THE EFFECTS OF INCORPORATING LITERACY INTO A HIGH SCHOOL ENVIRONMENTAL SCIENCE CLASSROOM

by

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ABSTRACT

The purpose of this research project was to study the effects of incorporating scientific literacy into a high school environmental science classroom. The methods used assessed students' content knowledge, attitudes, and confidence. Students were provided with a variety of ancillary methods relating to content material and real-world applications. The overall treatment incorporated three units of study. The first unit of study was on the human population and incorporated basic textbook content material. The second unit of study was on environmental health. The second unit used the pedagogy of the first unit. In addition, students collaborated on ancillary textbook materials which facilitated the connection between content knowledge and real-world applications. The third unit of study was on soil and agriculture. The pedagogy in this unit included all teaching methods from the first two units. Additional ancillaries were incorporated into this unit in the form of a case study, a documentary, and a current event. The purpose of additional ancillaries beyond the text was to further the connection of environmental science content material to real-world applications, and to improve students' attitudes and confidence. Data were collected using student pre-treatment and post-treatment assessments, surveys, and interviews. In addition, teacher data were collected using classroom teacher and colleague observations. Observations were employed to gain understanding of students' interest and academic needs and to assess teacher pedagogy practices. The data indicated an overall improvement of students' understanding of content material. Data also indicated an overall decline in students' attitudes and confidence at the conclusion of this research project.

INTRODUCTION AND BACKGROUND

For the last eleven years I have been teaching at an Archdiocesan private co-educational high school in Downingtown, Pennsylvania, a suburb of Philadelphia. The student population for the school year 2014-2015 was 1,149 students; 581 females and 568 males, most of whom came from middle to upper class families. Approximately one quarter of the students required financial assistance. The students came from 32 different Catholic parishes and from 23 different school districts. Of the students, 1,078 were Catholic and 71 students were non-Catholic. Over the past several years the ethnic diversity of the student population had been increasing with the majority continuing to be Caucasian. The ethnicities included 28 Asian, 23 African American, 23 Hispanic, 1 Native American, and 6 multi-racial. There were 27 students that emigrated from foreign countries (http://Shanahan.org).

Before assuming the role of an environmental science teacher, I taught biology and an introductory course in chemistry and physics. During the last five of my sixteen years of teaching, I had been exclusively teaching environmental science, and for the last three years I have been the sole environmental science teacher at our school. The students in environmental science classes included both junior and senior students. There were three classes of environmental science: two honors level classes and one college preparatory class for a total of 87 students. The college preparatory class was a lower level class which was recently restructured into a heterogeneous mixture of three lower educational levels of students with varying academic abilities.

Prior to teaching, I spent twenty years working in both clinical and research microbiology. My reasons for changing careers were multifaceted. First, I wanted to learn more about educational pedagogy and combine it with my science background to encourage and inspire students to develop more of an interest in science. Second, I wanted to help students of all levels of cognitive abilities to learn beyond the required content material and beyond the classroom. I also wanted to help students with no aspirations of science careers to become scientifically literate. I wanted my students to develop the ability to relate, incorporate, and apply science concepts to their everyday lives. I hoped to help students make ongoing connections between the importance of environmental science and current environmental science issues such as sustainability, stewardship, ethics, ecosystem capital, politics and policies, and globalization. I wanted my students to develop an awareness of the importance of these issues and to understand the interdisciplinary concepts within environmental science. Most importantly, I wanted to help my students understand the importance of the connections of these issues to their daily lives. With this knowledge, hopefully my students would acquire the skills necessary to make decisions concerning environmental science issues in their lives and work towards becoming stewards of the environment as future citizen scientists.

As I became more comfortable in my role as a teacher of environmental science, I observed my students and focused on listening to what they were saying. Gradually, as our roles reversed, my students taught me how to best restructure the course to accommodate their academic needs and to help them formulate attitudes and opinions about environmental science issues. Since environmental science is not a required course, I have

always asked my students why they chose to take this course. Their responses varied: some wanted another science course on their college resume while other students thought a course such as physics would be too difficult a science to study because of the required math component. Additionally, some enrolled because their parents preferred they be in an academic class rather than a study hall. To my dismay, I also discovered many students never or rarely read the required textbook. They would rely on posted PowerPoint presentations and chapter study guides to learn content material just to pass assessments. Many students also indicated they wanted more hands-on activities rather than just relying on chapter work, worksheets, articles, and occasional documentaries.

It became apparent that I needed to learn how to effectively teach content material in a way that both interested and engaged all students, regardless of their academic levels, impetus, or career paths. All of these observations and conclusions led me to the topic of scientific literacy. In order to help increase students' awareness of environmental science issues, I decided that I needed to teach beyond the textbook -and beyond the classroom- if students were to acquire the necessary tools to practice applications of environmental science skills acquired in the classroom. Through these changes my immediate goal was to change students' interests and attitudes about environmental issues for the positive. The long term goal was to prepare students to become concerned citizen scientists. I hoped they would be able to apply their newly developed knowledge and skills to make informed decisions as stewards of the environment and as functioning members of society as future citizen scientists. Ultimately, the aim was to help foster an understanding and respect for biodiversity and for the importance of sustainability.

The focus question for this research was formulated with the following variables in mind: varying academic abilities, reasons for taking the course, and students' attitudes as well as their confidence in themselves regarding the ability to master environmental science. The main focus question was, *What are the effects of teaching scientific literacy in an environmental science high school classroom?* Subsequent focus questions were as follows:

1. *What are the effects on students' content knowledge of teaching scientific literacy in an environmental science high school classroom?*
2. *What are the effects on students' attitudes of teaching scientific literacy in an environmental science high school classroom?*
3. *What are the effects on students' confidence of teaching scientific literacy in an environmental science high school classroom?*
4. *Ultimately, will increasing scientific literacy in a high school environmental science classroom increase students' awareness of current environmental science issues and help facilitate their role of becoming future citizen scientists?*

CONCEPTUAL FRAMEWORK

What is scientific literacy? Why is scientific literacy important in education? How has scientific literacy been achieved in education? There are many definitions of scientific literacy but a main theme that evolves is that scientific literacy is an understanding of the world in which we live; it is the ability to make decisions about things that affect our everyday lives such as energy, health, natural resources, and the environment. Hazen and Trefil (2010) are of the consensus that, "Scientific literacy is not the specialized stuff of

experts but more the general, relevant knowledge used in political discourse and everyday life. Everyone should understand the nature of science as a way of knowing, or the types of questions science can or cannot answer. They should also understand the role of measurement, experiment, and mathematical analysis in science and the strengths and limitations of science in resolving complex societal debates." (p. 58)

Scientific literacy is not a new concept. It is also not simply about incorporating reading into the science classroom. There have been countless articles written and studies launched pertaining to science literacy. Recently there have been new efforts to improve scientific literacy across American classrooms. According to Daisey, Liggit, and Moore-Hart (2004), The American Association for the Advancement of Science (AAAS) and the National Research Council (NRC) are among two educational organizations trying to increase science performance and science comprehension in the classroom. This review explores the foundations of scientific literacy and focuses on the importance of the advancement of students beyond high school and college. It also addresses various techniques that have been employed and the outcome of those techniques.

Focusing more attention on scientific literacy is importance at the elementary, middle school, and high school levels is due to the deficits in scientific literacy found at the college level. After a 20-year study of 10,000 students it was determined that there is no detectable improvement in undergraduate scientific literacy. Antonellis, Buxner, Impey, Johnson and King addressed both science content knowledge and attitudes about science. The belief is that pseudoscience is also very prevalent. Science infiltrates our lives as workers, citizens, and as consumers of health and technology. It is the responsibility of

educators to affirm that individuals gain an understanding in the foundations of science to be able to make informed decisions that affect their daily lives and to improve overall scientific literacy.

Scearce (2007) offers another perspective which provides a rationale for developing scientific literacy in education. Because today's society thrives on technology and scientific knowledge that drives technology, daily decisions must be made which affect the world in which we live. Ideally scientific literacy would be integrated throughout many political, ethical, health, and economic arenas; recently, climate change has been politically debated with the United States and China being the first countries to formally address this issue. To understand the process of climate change, one must understand the basic concepts and methodology.

In 1985 the American Association for the Advancement of Science (AAAS) started Project 2061, a project that works on science reform in coordination with math and technology education. In K-12 education the author argued that there were deficiencies in the depth of the content being taught because teachers have been required to teach a wide scope of content with limited exploration into the content knowledge. The Project 2061 concluded that K-12 education has the greatest potential for improving scientific literacy among U.S. students (Scearce, 20).

The term scientific literacy has been used since the 1950's without any clear definition of what it means to be scientifically literate or goals on how to achieve it. Through the course of time it has been determined that success in teaching scientific literacy can be achieved through following a framework which consists of five components

of scientific literacy that have been defined for high school students. The first component is an explanation of science content, which is the primary goal of science instruction. The last four components include relating content to its historical perspective, understanding methodology behind the scientific process, being able to relate science content to societal impacts, and being able to relate science concepts to personal experiences. Incorporating these components into a high school science curriculum leads to increased context understanding. Success can be achieved by introducing these components in the beginning of the school year and by being consistent with their use throughout the year (Guthrie, 1985).

According to Wightman (2011), scientific literacy states that it should be integrated into all academic disciplines. Current educational programs support this rationale and emphasize the importance of scientific literacy in both K-12 and higher education. The creation of solid scientific foundations, along with the making of connections to real-world situations, helps facilitate the increase in scientific literacy. The more that is expected of students the more they will achieve. It was also recommended implementing teaching through the use of technology, collaborative learning and discussions, science writing, and creativity.

Another point of view from Grant and Lapp (2011) is that students must be taught to understand the impact of science on their world. Most students do not think about the effects of scientific issues on their lives and do not consider how they themselves could play a scientific role in a changing world. Four actions have been proposed to promote critical literacy in science classrooms. The first action is to identify science topics of

interests for the students— such as oils spills—and their effect on the environment. The second action is to engage students in reading research in various forms, such as articles, books, and poems. Scientists read journal articles to gain or to build background knowledge on specific topics; educators should teach students to read like scientists (Grant & Lapp et al., 2012). This is accomplished by developing an understanding of important content vocabulary, reading and interpreting graphs, data charts, data tables, and data analysis. It is also important to help students evaluate data from professional internet sites such as the National Oceanic and Atmospheric Administration (NOAA) and the United States Environmental Protection Agency. Students need to learn the skill of interpreting data so that they can interpret data relative to their lives.

Finally, the College High School Literacy Network has designed early action literacy plans which identify science literacy strategies which have been found to prepare high school students with the competencies needed in scientific literacy to be successful in college science courses. The aim of the study was to build students' skills in reading, writing, and critical thinking in order to increase their understanding of science content and to help students to think like scientists. One of the strategies implemented to improve science literacy included having students read 80 science articles throughout the school year. Improvement in the students' reading, reasoning, and writing abilities was evident within weeks of the implementation of this strategy (Bayerl, 2007).

Scientific literacy is continually being addressed by The National Science Teachers Association (NSTA) through publications of science journals and books. In a book published by NSTA titled, *Front Page Science: Engaging Teens in Science Literacy*,

science literacy assessment strategies are presented for teachers to utilize in the classroom. According to *Front-Page Science: Engaging Teens in Science Literacy*, the goal is for students to not be afraid of science and to recognize the relevance of science in their daily lives. Additionally, the authors of this publication hope that students will know how to find relevant information when they need to do research and that they will be able to synthesize the information using multiple sources. And finally, students would be able to relay information based on previous content knowledge and research to make the information applicable to their daily lives and society (Kohnen, Newman, Pearce, Saul, 2012).

Scientific literacy is not solely about the incorporation of reading into the science classroom. It is about reading, writing, synthesizing, and analyzing, in hopes of increasing science content knowledge and increasing science literacy for all students (K-12) and beyond the classroom into adulthood. Furthermore, scientific literacy is about producing students who will be successful in college level coursework. Ultimately, Hazen asserts that increasing scientific literacy will afford all individuals opportunities to form educated opinions about science-based issues that may affect their daily lives. These skills will prepare individuals to participate fully in intelligent and reflective ways in the 21st century (Hazen, 2002).

The following quote by Scearce (2007) puts science literacy in the classroom into perspective:

> Decisions that we make every day have the capacity to affect energy consumption, our personal health, natural resources, and the environment—ultimately the well being of ourselves, our community, and the world. Individual decisions may not seem to be critical, but when they are multiplied 300 million nationwide, or nearly 7 billion worldwide, they have the power to change the face of the planet. (p.3)

In summary, the importance of scientific literacy is addressed at various levels of education, to help ensure the success of students across curriculums and beyond formal education. Scientific literacy is studied worldwide through empirical research and evaluated through varying assessment strategies by educators in classrooms. Changes in science curriculums are due to the continual development and improvement of science standards. Standards such as the K-12 Framework for Teaching, The Next Generation Science Standards and Common Core Standards are the driving forces of these changes. Advocates of scientific literacy in the classroom assert that scientific literacy should begin at the grade school level and continue through high school and beyond. Continued development of science content knowledge and critical reflective thinking skills, which extend beyond formal education and into the adult years, will prepare individuals for their future. Ultimately, scientific literacy should prepare students for becoming decision-makers and citizen scientists in their everyday lives. This will assist them in becoming functioning members of society and contribute to the sustainability of the planet (Antonellis et al., 2011). It is apparent from the above research that the foundations for scientific literacy must begin at the elementary level and continue through secondary and college levels of education. It is our job as educators to help facilitate the process of scientific literacy education, and to aspire for our students to become well informed citizen scientists beyond the boundaries of formal education.

METHODOLOGY

This classroom research project consisted of three high school environmental science units. The unit topics included: The Human Population, Environmental Health, and

Soil and Agriculture. These units of study were chosen as important environmental science topics for increasing students' awareness of sustainability issues. There were multiple factors that guided this study in trying to achieve scientific literacy among my students. One factor was that the boundaries of knowledge cannot be confined to classroom materials. It is the responsibility of educators to incorporate pedagogical practices that challenge our students through real world applications of content material to increase students' scientific literacy (Saul, Kohnen, Newman, & Pearce, 2012). Another reason for this research was the need to help students recognize their inhibitions related to the study of science and the relevance of science in their daily lives. Finally, I was motivated by the desire to help students apply what they learned to their daily lives and to society (Saul, Kohnen, Newman, & Pearce, 2012). It was necessary for me to investigate my own need to expand pedagogy beyond required textbook content and the classroom to help increase scientific literacy (Withgott, 2011). The New Generation Science Standards state that science education is important for students to be able to make informed decisions related to science (NGSS Lead States 2013.) The final deciding factor for choosing to research scientific literacy is the attention that The National Science Teachers Association has devoted to this topic in multiple publications.

Data collection for this research occurred from February 2015 through April 2015 with one class of environmental science students. The class was a college preparatory class, a heterogeneous mixture of three lower level tracks students. The total number of students was 26, with a male to female ratio of six to seven. Five male students and one female student received individual education programs. The research methodology for this project

received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (Appendix A).

A central assumption about this research was that literacy interventions would increase students' positive attitudes about scientific literacy and their role as citizen scientists, leading to a development in students' overall scientific literacy. Another assumption was there may be an overall increase in content knowledge. It was also believed that, due to their lack of interest in the sciences, some students would not have increased attitudes or confidence in scientific literacy. There could also be a decrease in unit assessment scores due to the fact that some students would not look favorably upon the additional work involved in the design of this research project. Adding to the above assumptions in this research study were varied teaching strategies that went beyond the text. These were accomplished through the incorporation of a case study, a current event, and a documentary. The alternative assessment strategies were chosen to be applicable to real world science issues and were intended to improve the overall scientific literacy of my students. This research was performed to with the intent of having my students recognize the relevance of environmental science issues in their lives. This research was also performed to hopefully increase the overall improvement of students' general attitudes and confidence in environmental science. A final assumption was that I would be inspired to continue to incorporate scientific literacy ancillaries in the teaching of all my future science disciplines.

There were a number of surveys that were administered to increase the validity of the research project. Before implementation, students were provided with three surveys. A

Likert-Style Test of Science-Related Attitudes (TOSRA) survey was used to assess student's attitudes toward towards general science (Appendix B). In the TOSRA survey there were seven science-related attitudes scales, and classifications for each scale which were created for high school students and measured using the following categories listed in table one.

Table 1
Name and Classification of Each Scale in TOSRA

Scale Name	Klopfer (1971) Classification
Social Implications of Science	Manifestation of favorable attitudes towards science and scientists
Normality of scientists	
Attitude to Scientific Inquiry	Acceptance of scientific inquiry as a way of thought
Adoption of Scientific Attitudes	Adoption of scientific attitudes
Enjoyment of Science Lessons	Enjoyment of science learning experiences
Leisure Interest in Science	Development in interest in science and science- related activities
Career Interest in Science	Development of interest in pursuing a career in science

The TOSRA survey was developed by Frasier in 1981. The TOSRA survey was administered pre, mid, and post treatment. There were 70 questions. Questions were answered as and values were assigned to each answer as*; strongly agree* (5), *agree* (4), *undecided* (3), *disagree* (2), and *strongly disagree* (1). Responses to questions were averaged together to attain mean percentages for each student.

The second survey was the self-developed Rossana Scientific Literacy Survey (RSLS) that was modeled after the TOSRA Survey (Appendix C). The RSLS was administered pre, mid, and post treatment. It was comprised of 60 questions that correlated to content and ancillary materials for the three units of study. Questions were answered on a *true*, *false*, or *I do not know* basis and were graded for correctness. Correct answers received one point. Incorrect answers received minus one point. I do not know answers were answers were assigned zero points. Answers were assigned numerical values and averaged to attain mean percentages.

The third survey was the Rossana Confidence Survey (RCS) with Likert-Style questions (Appendix D). The RCS was administered pre, mid, and post treatment. The survey contained thirteen questions. Questions were answered as and values were assigned to each answer as; *very* (5), *somewhat* (4), *not very* (3), and *not at all* (2). Responses to questions were averaged to attain mean percentages.

The fourth survey was the Rossana Confidence and Attitude Survey (RCAS) (Appendix E). The RCAS was administered pre-treatment and post-treatment only. The survey contained thirteen questions. Questions were answered as and values were assigned to each answer as; *strongly agree* (5), *agree* (4), *indifferent* (3), *disagree* (2), and *strongly disagree* (1). Responses to questions were averaged to attain mean percentages. In addition to the above questions, the survey included five free response questions.

Pre-assessments and post-assessments were administered for each unit of study (Appendix F). Each assessment was weighted equally in both points and types of questions. Questions were selected for transfer of students' knowledge, comprehension, application,

evaluation, and analysis. Assessment scores were analyzed based on mean percentages for each student and overall significant gain.

There were pre-treatment and post-treatment student interviews (Appendix G). Six students were selected for pre-treatment and post-treatment interviews based on class averages from the first semester of the school year including two high-achieving, two average-achieving, and two low-achieving students. There were twenty questions that the students answered orally and individually at my desk. Students' answers were recorded as each question was answered using transcription software. Student interview responses were used as evidence for claims made through the analysis of the quantitative data.

There were five colleague classroom observations (Appendix H). Observation prompts were provided to assess students' engagement, attitudes, ability to ask and answer questions, interest, and being on task. Colleagues were not assigned when to observe students. Students were observed depending on colleague availability.

Finally, there was a student course accommodations- recommendations survey (Appendix I). Observational data was used as evidence to support other data claims.

Three units of study were researched through a mixed method procedure which used both qualitative and quantitative analysis strategies to strengthen the research (Creswell, 2009). The first unit of study was a non-treatment unit that employed traditional pedagogical practices as a way to set a baseline for comparison purposes. The second unit of study employed treatment strategies using content material and ancillary material from the textbook. The final treatment strategy included content and ancillary material from the textbook and additional ancillary sources.

Before the first unit began, students completed a pre-assessment test. Content material was then presented through lecture and a PowerPoint presentation. At the end of each unit section, students collaboratively answered textbook-generated assessment questions and completed assessment quizzes. A post-assessment test was administered which was the same as the pre-assessment test. The TOSRA attitude survey, scientific literacy survey, the attitude and confidence survey, and the confidence survey were administered at this time. Surveys were administered at the end of each unit of study for uniformity. At this time pre-treatment student interviews were conducted.

The second unit of study was on Environmental Health. Prior to starting the unit, a pre-assessment test was administered. The unit on Environmental Health employed all previously mentioned traditional teaching practices. The variance for this unit was the inclusion of ancillary material supplied by the textbook. Section one of the unit had an activity on environmental ethics, section two incorporated a quick lab on The Spread of Disease and section three asked a question from the text relating environmental health to the students' own health. Section three of the unit addressed possible sources of indoor air pollution in the students' school. Section four of Unit Two employed a mapping activity addressing earthquakes. At the conclusion of Unit Two, students read different viewpoints on environmental health and formulated conclusions. Upon completion, a post-assessment test was administered which was the same as the pre-assessment test. On genetically modified foods

The third unit incorporated all of the aforementioned methodologies. Additionally incorporated in this unit were a case study, a documentary, and a current event. The third

unit began with a central case from the text on transgenic maize. In section one, students performed an in-class activity on analyzing soil. Section two asked a question from the central case. In section three, students performed a mapping activity that addressed the origins of agriculture. In section four students evaluated the labeling of genetically modified foods. Textbook ancillaries ended with a section that required students to address— in writing— past and present agricultural practices.

The case study was chosen for its inquiry and debate nature on the topic of genetically modified foods (Herried, Nelson 2002). Students worked in collaborative groups before having a class discussion. Prior to the current event, each group of students was provided with two articles. One article was pseudoscience and one article was sound science. Students read the articles in their collaborative groups. Students wrote a minimum of five statements from each article that led them to a conclusion about the scientific validity of the article. Group discussions were followed by class discussions which led to conclusions about which article was pseudoscience and which article was sound science. This strategy was implemented to help students choose sound scientific articles for their current event. Students used school databases to research current event topics on agriculture and peer-reviewed each other's work before finalizing their reports. Students also wrote summaries of their articles. To facilitate critical thinking skills, in addition to a summary, students wrote reaction paragraphs. Reactions paragraphs included how the topic of their article was relevant in their lives currently or how the topic may be relevant to their lives in the future.

The final varied assessment assignment was a documentary on agricultural practices in the United States, the regulatory actions of food processing, and the effects regulatory actions had on the agricultural industry and consumers. This assignment had an accompanying worksheet that was completed while viewing the documentary. Following the viewing of the documentary, students worked collaboratively to help identify missing information. A class discussion followed. Finally, individual reaction essays were written in reference to the documentary.

The case study, the current event, and the documentary were used to enhance content material (Merriam, 1998). The above varied assessment teaching strategies were administered after the unit section quizzes and before the unit assessment on agriculture.

Upon completion of the third unit of study, post-treatment student interviews were conducted. These specific analysis strategies focused on students' content knowledge and students' attitudes and confidence about environmental science. Throughout the study, observations were made regarding students' motivation, attitudes, and engagement. Reflective journaling was used for teacher insights into pedagogy and teacher attitudes and confidence levels in classroom practices. Data collected in this research study was both qualitative and quantitative. Qualitative descriptive data was sorted by gender as well as educational needs. Additional qualitative data was assessed for trends and patterns. Quantitative data was also assessed for trends and patterns for all pre-treatment, mid-treatment, and post-treatment analysis. Data were analyzed using comparisons of the mean, median, and mode, standard deviation, and t-tests. Assessment results were evaluated for

significance and all data was reported using mean percentages. Focus questions and coordinating data sources addressing each focus question are illustrated in data table two.

Table 2
Triangulation Matrix

Focus Questions	Data Source 1	Data Source 2	Data Source 3	Data Source 4	Data Source 5	Data Source 6	Data Source 7
Primary Question: 1. What are the affects of teaching scientific literacy in an environmental science high school classroom?	Summative Unit Assessment (Pre and post instruction delivery)	TOSRA Attitude Survey (Pre, mid and post instruction delivery)	Rossana Scientific Literacy Survey (Pre, mid and post instruction delivery)			Student Interviews (Pre and post instruction delivery)	Teacher Classroom Observations (ongoing) Colleague Classroom Observations (post)
Secondary Questions: 2. What are the effects on students' content knowledge?	Summative Unit Assessment (Pre and post instruction delivery)		Rossana Scientific Literacy Survey (Pre, mid and post instruction delivery)				Teacher Classroom Observations (post) Colleague Classroom Observations (post)
3-What are the effects on students' attitudes?		TOSRA Attitude Survey (Pre, mid and post instruction delivery)			Rossana Confidence and Attitude Survey (Pre and post instruction delivery)	Student Interviews (Pre and post instruction delivery)	Teacher Classroom Observations (ongoing) Colleague Classroom Observations (post)
4- What are the effects on students' confidence?				Rossana Confidence Survey (Pre, mid and post instruction delivery)	Rossana Confidence and Attitude Survey (Pre, mid and post delivery)	Student Interviews (Pre and post instruction delivery)	

DATA AND ANALYSIS

The results of the TOSRA Survey from pre-treatment to mid-treatment analysis indicated that there was a slight decrease in students' attitudes about science (*N*=26). The data revealed a drop in scores of students' attitudes of 2% pre to mid-treatment, 1% mid to post-treatment and overall pre-treatment to post-treatment analysis indicated a 3% decrease in their overall attitudes about science (Table 3). The survey contained 60 questions. Questions were answered using the following responses: strongly agree, agree, undecided, disagree, and strongly disagree. Students expressed frustration both by the length of the survey and repetitiveness of the questions. One student asked, "Are all of your surveys going to have this many questions?" After administration of this survey one student declined further participation in the research study. The statement students most strongly disagreed with was: I would like to be given a science book or a piece of science equipment as a present. Pre-treatment 85% disagreed. Post-treatment only 53% of students disagreed indicating an overall 32% increase positive attitudes about this statement. Responses to questions were averaged together to attain mean percentages. A higher average indicated an overall positive outlook on science while a lower average indicated a more negative outlook on science. The statement, *I am curious about the world in which we live* revealed in a 29% decrease in students' interests. Pre-treatment 92% of students were *curious*, post-treatment only 73% were *curious* about the world they live in. In response to the statement *I would like to be a scientist when I leave school*, pre-treatment 4% of students indicated they would *like to be a scientist*, post-treatment result of 8% for an overall increase of 2%.

Table 3
Survey and Assessment Percentages

TOSRA	2% ↓	1% ↓	3% ↓
Scientific Literacy	97% ↑	37% ↑	170% ↑
Confidence	3% ↓	3% ↑	0%
Confidence/ Attitude			6% ↓
Assessments Chapter 9 Chapter 12			31% 63% ↑

The results of the Scientific Literacy Survey from pre-treatment to mid-treatment analysis indicated that there was a 97% overall increase in students' content knowledge. The results of the survey from mid-treatment to post-treatment indicated a 37% increase. And the pre-treatment to post- treatment analysis indicated that there was a 170% overall increase in content knowledge (Table 3).

Also indicated in the Scientific Literacy Survey, are the number of times students responded, *I do not know* Results from pre-treatment to mid-treatment indicated a 43% decrease. Mid-treatment to post-treatment responses indicated a 27% decrease. And, pre-treatment to post-treatment indicated and overall 59% decrease in number of *I do not know responses* (Table 3). There were seven questions that the majority of students answered incorrectly. Six of the questions, although related to content material, pertained to information from ancillary materials. The results of this survey correlated to students'

responses from student interviews. The statement; *do you think learning science is important even if you are not going to pursue a career in science*, resulted in 100% of the students responding positively. During the interviews, one student said, "Yes because you should have a basic knowledge about things." This indicated students understood the *importance* of having basic knowledge of environmental science.

Results of the Confidence Survey from pre-treatment to mid-treatment analysis indicated that there was a 3% decrease in students' confidence in learning science. Mid-treatment to post-treatment results indicated a 3% increase in students' confidence resulted in an overall 0% increase/decrease in students' confidence levels from pre to post survey. Confidence levels were as follows: Pre-treatment 100% of students indicated they were confident, mid-treatment 96%, and post-treatment 100% (Table 3).

Results of the Confidence and Attitude Survey were analyzed into various categories. The results of the Confidence and Attitude Survey from pre-treatment to post-treatment analysis indicated that there was an overall 6% decrease in students' confidence and attitudes (Table 3). Analysis of this survey was divided into the following categories: total males, total females, students receiving special educational services, students not receiving special educational services, juniors, seniors, and total students.

The breakdown of categories from the Confidence and Attitude Survey had the following results. Male students': a 25% increase, 75% decrease, and 0% students with no change in attitude and confidence from pre-treatment to post-treatment. Female students' results were a 29% increase, 57 % decrease, and 14% with no change. Communication skills students results indicated: a 33% increase, 67% decrease, and 0% students with no

change. Non-communication skills students results indicated: a 25% increase, a 65% decrease, and 10% students with no change. The total number of junior students' results indicated: a 23% increase, 77% decrease, and 0% students with no change. The total number of senior students' results indicated: a 31% increase, 54% decrease, and 15%students with no change. Total cumulative results indicated: a 27% increase, 65% decrease, and 8% students with no change (Table 4).

Table 4
Confidence and Attitude Categories

Pre and Post Treatment Percentages			
	Percent Increase	Percent Decrease	No Change
Males	25%	75%	0%
Females	29%	57%	14%
IEPs	33%	67%	0%
Non-IEPs	25%	65%	10%
Juniors	23%	77%	0%
Seniors	31%	54%	15%
Cumulative *N*-26	27%	65%	8%

The confidence and attitude survey also incorporated five free response questions. Three questions addressed students' best methods of learning. Two questions addressed scientific literacy. *When students were asked if they thought they were scientifically literate*, pre-treatment 72 % of students replied that they were scientifically literate. Post-treatment, 48% of students replied that they were *scientifically literate*. One student answered the same both pre-treatment and post-treatment: "I think this class has helped me on the way to becoming literate, but I'm not certain I'm completely there yet."

Chapter 8 assessment was excluded from the research project due to lack of returned pre-assessments. This was due to data being collected the previous year and having no way to recover missing data. Chapter 9 data revealed an increase in assessment

scores of the respondents (Figure 1). Analysis of this survey was divided into the following categories: total males, total females, students receiving communication skills services, students not receiving communication skills services, juniors, seniors, and total students.

The results were a 92% increase for juniors and 100% increase for seniors. There was an 8% difference in averages between juniors and seniors. Female students revealed a 93% increase while male students revealed a 92% increase with only a 1% difference in averages. Communication skills students revealed a 100% increase in assessment scores. Non-communication skills students' results indicated a 93%% increase. Chapter 9 assessment revealed a 31% increase in overall grade averages (Table 5).

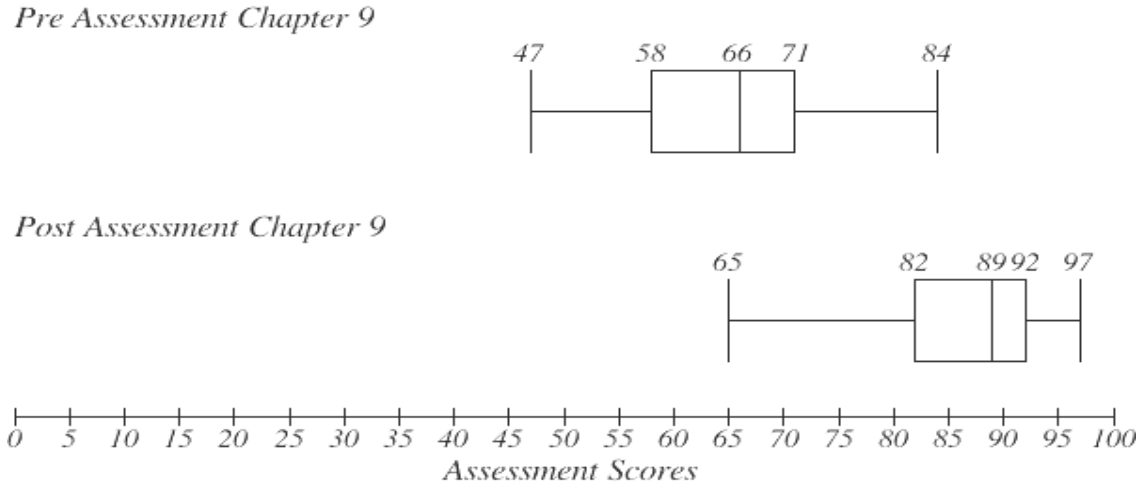

Figure 1. Chapter 9 Assessment Scores, (*N*=26).

Table 5
Chapter 9 Assessment Scores

Pre to Post Treatment % Increases	
Males	92%
Females	93%
IEPs	100%
Non-IEPs	93%
Juniors	92%
Seniors	100%
Cumulative *N*=26	31%

Chapter 12 data revealed an increase in assessment scores of the respondents (Figure 2). The results were a 92% increase for juniors and a 93% increase for seniors. There was only a 1% difference in averages between junior and senior students. Both female and male students revealed a 100% increase. Communication skills students revealed a 100% increase in assessment scores. Non-communication skills students' results indicated a 93%% increase. Chapter 12 assessment revealed a 63% increase in overall grade averages (Table 6). Assessment tests had the most significant t-score values indicating there was a relatively low chance that the scores were the same due to repetitive pre and post assessment material. During student interviews, when asked which methodologies from environmental science class helped students learn concepts best, 50% of the students pre-treatment, and 67% post-treatment indicated that reading the text and doing chapter work helped them the most with conceptual learning. Post-treatment 67% of the students reported the same information which correlates to increases in assessment scores pre-treatment to post-treatment.

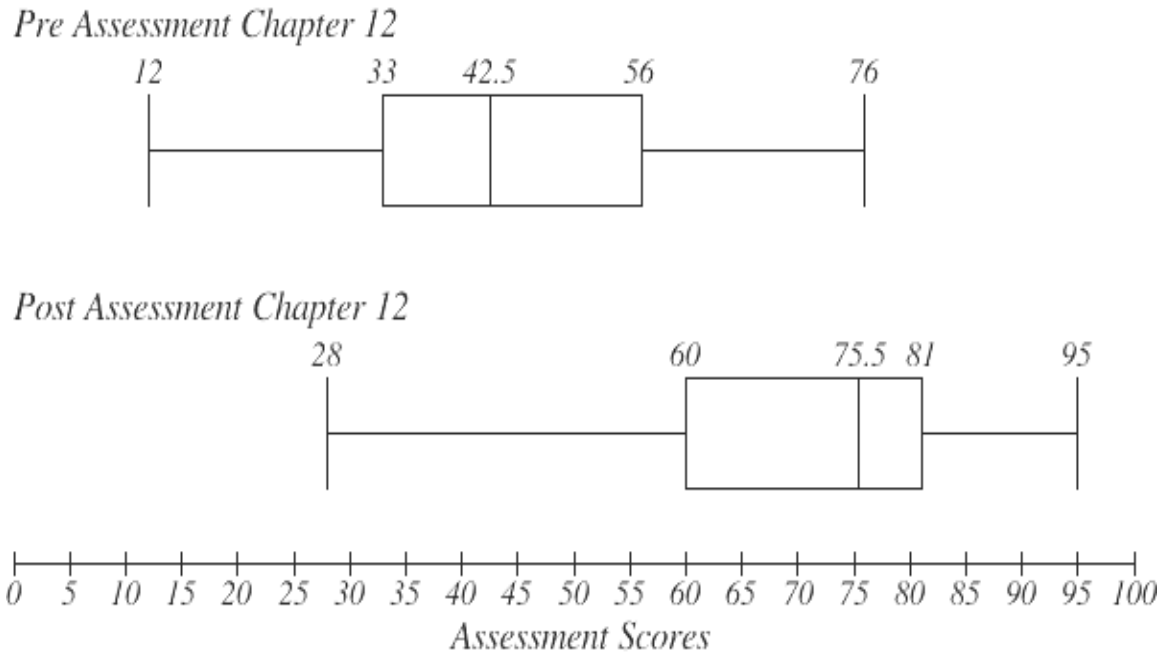

Figure 2. Chapter 12 Assessment Scores, (*N*=26).

Table 6

Chapter 12 Assessment Scores

Pre to Post Treatment % Increases	
Males	100%
Females	100%
IEPs	100%
Non-IEPs	93%
Juniors	92%
Seniors	93%
Cumulative *N*=26	63%

There were several additional qualitative data measurements, including my daily classroom observations, colleague observations, and a student accommodations/recommendations survey. One of my observations that was most profound was how excited students were to view the documentary. One student said "I saw this before." Another student asked, "Are you a vegetarian?" This was not surprising since students' free response questions revealed that their second best methodology for learning was through documentaries. Colleague observations were performed on classroom activities. Teachers were prompted to assess: engagement, attitudes, questioning, interests in subject matter, on task, and other. All prompts reported positive behavior with the exception of the case study. With regards to the case study, one teacher reported: "Students were confused about where to research answers to questions even though websites were provided. Students were interested in the case study. They were not interested in doing research." One student asked, "Can we make a slide presentation of our work? " Colleague observations were helpful with obtaining different perspectives on students' attitudes and confidence pertaining to their work.

INTERPRETATION AND CONCLUSION

Data were analyzed to address my focus questions. The effects of teaching scientific literacy were overall positive. Most students understood the importance of being scientifically literate. One student stated it best by saying: "Yes it can help you become a responsible citizen and an informed consumer." Even students who had no interests in a post secondary pursuit of science indicated that "Science is a big part of our world." One student stated that, "One should be scientifically literate enough so that you can carry on a

simple conversation. No need to be a science genius spitting out big words but enough to understand". Part of my passion about being a high school science teacher is to teach to reach all students. This was especially important with this heterogeneous class of students. Results indicated that the majority of my students realized the importance of becoming scientifically literate.

The effect on students' content knowledge showed vast improvement in my research study. The use of a case study, a documentary, a current event, and textbook ancillaries showed that students gradually gained knowledge of concepts over the course of the study. Students showed interests in the topics of the ancillary activities and remained engaged throughout classroom activities. Results of the content survey were profound and informative. Although it was difficult to formulate the content survey and structure it to correlate with text and ancillary materials, it was gratifying to know that the results were significant. There was an unexpected outcome concerning students' responses to which methods of learning helped them learn content knowledge the best. The majority of students still preferred basic pedagogy to help reinforce concepts, in learning terminology, reading, outlining chapters, and chapter work. My preconception was that my students would have preferred ancillary material over textbook material. I have learned the importance of structure and maintaining a strong foundation in textbook materials in addition to ancillary materials to help ensure students' success.

The effects on students' attitudes about science were disappointing. The expected outcome for attitudes was to see an increase in possible attitudes as the study progressed. Instead students' possible attitudes decreased. I can conclude from these results that my

assumption about students' thinking, that surveys and additional assessments were too cumbersome for students to maintain their interests, were correct. Although students enjoyed content topics and ancillary activities they looked negatively on the overall additional class work and surveys. In the future, there would be implementation of fewer surveys, surveys would be shorter in length, and surveys would only be administered pre and post.

The effects on students' confidence were similarly affected by additional work which was reflected on the likert type surveys. However, free response answers indicated positive responses in their confidences in becoming scientifically literate and in being able to make informed decisions as consumers and in caring for the environment. Through free response questions, an overall improvement in students' confidence became evident. In addition, it became apparent over the course of the study that students gradually became more comfortable working with ancillary materials.

The final focus question concerned increasing scientific literacy in a high school environmental science classroom, to increase students' awareness of current environmental science issues and help facilitate their role of becoming future citizen scientists? This research study could not predict future actions of students. What this study hopefully did was provide my students with foundational tools to research and analyze information to help them make sound science decisions. It also provided them with an awareness of specific environmental science issues. Hopefully my students were inspired to continue to pursue environmental science issues throughout their lives. Ultimately, I hope that their

scientific literacy skills will continue to develop and evolve to help them understand the relevancy of science in their lives and the importance of their roles as citizen scientists.

VALUE

This action research project has helped my educational practices and thinking in several ways. First and foremost was that I need to learn from my students and listen to what they are telling me. I learned the importance of this class of students' need for continual foundational learning. In trying to improve scientific literacy with my students I incorporated ancillary material which became the main focus of learning. My students made it clear that for them to be successful in traditional test assessments, they need to learn vocabulary, read the text, and answer text questions in addition to ancillary material. I now realize the importance of coordinating foundational materials with appropriate amount of ancillary materials, especially with educationally diverse students. Students expressed their views in the Course Accommodations Recommendations Survey that was administered at the end of this study. The information received was valuable. I will administer this survey to all future classes, pre-course and post-course, in all disciplines to help modify my teaching to different learning styles.

After experiencing the success of the Scientific Literacy Survey, I have decided to make a survey for all of my classes and administer it both pre-course and post-course. The survey helped with awareness of specific topics that students would be addressing with each unit of study. Planning will have to take place well in advance of the start of a course. However, administering this survey will not limit me to new and relevant material during the course of the school year.

There were other accommodations and recommendations that students expressed. The first was viewing documentaries. Students requested more documentaries because they related to real-world situations. In order to incorporate more documentaries I would have to edit them to show the most relevant sections. Students requested not to have case studies. Case studies are a practice I have incorporated into my teaching since taking the anatomy and physiology course at Montana State University. I will keep the use of case studies with all of my classes. With lower track students I will reduce the length of the content requirements for the case studies. This should lessen their work load but still provide educational value and science skills for the specific topic.

Two other recommendations were chapter outlines and current events. This class of students liked outlining the chapters, however the process was tedious. I developed a concept outline technique that is currently used with all my classes. Students take each topic from each section of a chapter and explain the concept in just a few sentences. If they can explain the concept, they are reinforcing their learning. The results have been positive, and students like this method of outlining. Current events are not a favorite among my lower track students. I will continue to assign current events but I will limit them to one per quarter. With current events it is not just the topic that is important but also the research of sound science articles. It is the use of proper databases. It is the article summary in their own words. It is the practice of peer review. Most importantly, it is a reaction paragraph and relevance to their lives that helps them learn real-world issues.

For the 2016-2017 school year the Office of Catholic Education is instituting critical reading training to address cross-curricular literacy for all teachers in the 17 high

schools of the archdiocese of Philadelphia. In order to continue advancing scientific literacy among my students I have volunteered to be on the committee in my school for the science component. Also, because of this research project scientific literacy was taught and continually expressed in all of my classes this past year. As the year progressed students would mention in their writings the importance of scientific literacy. Literacy is an important component in all disciplines. Scientific literacy is important in every ones' daily lives. I will continue my passion of teaching scientific literacy among my students and desire to inspire them in becoming scientifically literate future citizen scientists.

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APPENDICES

APPENDIX A

INFORMED CONSENT

Informed Consent and Assent Form for Students in the Study

The purpose of this research project entitled " SCIENTIFIC LITERACY: THE EFFECTS OF INCORPORATING LITERACY INTO A HIGH SCHOOL ENVIRONMENTAL SCIENCE CLASSROOM" examines the effects that varied science literary strategies have on increasing student content knowledge and attitudes in a high school environmental science class. For this project, students will be asked to complete quizzes, tests, a case study, a documentary, a current event article, interviews, pre and post content and attitude surveys, pre, mid, and post confidence and attitude surveys, and pre and post assessments. All of these data collection instruments fall within the area of common classroom assessment practices.

Identification of all students involved will be kept strictly confidential. Most of the students involved in the research will remain unidentified in any way, and their levels of environmental interaction will be assessed and noted. However, six students will be selected for interviews based on the following criteria: participation, interest, comprehension, attitude and awareness of scientific literacy. Nowhere in any report or listing will students' last name or any other identifying information be listed.

There are no foreseeable risks or ill effects from participating in this study. All treatment and data collection falls within what is considered normal classroom instructional practice. Furthermore, participation in the study can in no way affect grades for this or any course, nor can it affect academic or personal standing in any fashion whatsoever.

There are several benefits to be expected from participation in this study. First, the intent is to inspire my students to make the connection of the importance of environmental science issues such as sustainability, stewardship, ethics, ecosystem capital, politics and policies, and globalization in the content areas of The Human Population and Agriculture. To not only stress the importance of these issues, but also have them understand how these issues are encompassing parts of environmental science. In addition, to bridge a connection to understanding the importance of how these issues affect their daily lives in the present and how they will affect their lives in the future. During this process I have become a student in my own classroom by listening to my students and addressing their needs to help them to be as successful as they can in the classroom and hopefully in the future.

Participation in this study is voluntary, and students are free to withdraw consent and to discontinue participation in this study at any time without prejudice from the investigator.

Please feel free to ask any questions of Mrs. Rossana via e-mail at lrossana@ shanahan.org, by phone at 610-518-1300, ext. 4263, or in person before signing the Informed Consent form and beginning the study, and at any time during the study.

Parent signature: _____
Student signature: _____

Date: _____

APPENDIX B

TOSRA SURVEY

TOSRA SURVEY QUESTIONS

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Test of Science Related Attitudes (TOSRA)
(Fraser, 1981)

Directions:
1. This survey contains numerous statements about science. You will be asked what you think about these statements. There are **NO** *right* or *wrong* answers. Answer *honestly* with your own opinion about each statement.
2. For each statement, draw a circle around the specific numeric value corresponding to how you feel about each statement. **Please circle only ONE value per statement.** This survey will **NOT** affect your grade in this class in any way.

5 = Strongly Agree **(SA)**
4 = Agree **(A)**
3 = Uncertain **(U)**
2 = Disagree **(D)**

Statement	**(SA)**	**(A)**	**(U)**	**(D)**	**(SD)**
1. Money spent on science is well worth spending.	5	4	3	2	1
2. Scientists usually like to go to their laboratories when they have a day off.	5	4	3	2	1
3. I would prefer to find out why something happens by doing an experiment than by being told.	5	4	3	2	1
4. I enjoy reading about things that disagree with my previous ideas.	5	4	3	2	1
5. Science lessons are fun.	5	4	3	2	1
6. I would like to belong to a science club.	5	4	3	2	1
7. I would dislike being a scientist after I leave school.	5	4	3	2	1
8. Science is man's worst enemy.	5	4	3	2	1
9. Scientists are about as fit and healthy as other people.	5	4	3	2	1
10. Doing experiments is not as good as finding out information from teachers.	5	4	3	2	1
11. I dislike repeating experiments to check that I get the same results.	5	4	3	2	1
12. I dislike science lessons.	5	4	3	2	1

Statement	**(SA)**	**(A)**	**(U)**	**(D)**	**(SD)**
13. I get bored when watching science programs on TV at home.	5	4	3	2	1
14. When I leave school, I would like to work with people who make discoveries in science.	5	4	3	2	1
15. Public money spent on science in the last few years has been used widely.	5	4	3	2	1
16. Scientists do not have enough time to spend with their families.	5	4	3	2	1
17. I would prefer to do experiments rather than to read about them.	5	4	3	2	1
18. I am curious about the world in which we live.	5	4	3	2	1
19. School should have more science lessons each week.	5	4	3	2	1
20. I would like to be given a science book or a piece of science equipment as a present.	5	4	3	2	1
21. I would dislike a job in a science laboratory after I leave school.	5	4	3	2	1
22. Scientific discoveries are doing more harm than good.	5	4	3	2	1
23. Scientists like sports as much as other people do.	5	4	3	2	1
24. I would rather agree with other people than do an experiment to find out for myself.	5	4	3	2	1
25. Finding out about new things is unimportant.	5	4	3	2	1
26. Science lessons bore me.	5	4	3	2	1
27. I dislike reading books about science during my holidays.	5	4	3	2	1
28. Working in a science laboratory would be an interesting way to earn a living.	5	4	3	2	1
29. The government should spend more money on scientific research.	5	4	3	2	1
30. Scientists are less friendly than other people.	5	4	3	2	1
31. I would prefer to do my own experiments than to find out information from a teacher.	5	4	3	2	1
32. I like to listen to people whose opinions are different from mine.	5	4	3	2	1
33. Science is one of the most interesting school subjects.	5	4	3	2	1

34. I would like to do science experiments at home.	5	4	3	2	1

Statement	**(SA)**	**(A)**	**(U)**	**(D)**	**(SD)**
35. A career in science would be dull and boring.	5	4	3	2	1
36. Too many laboratories are being built at the expense of the rest of education.	5	4	3	2	1
37. Scientists can have a normal family life.	5	4	3	2	1
38. I would rather find out things by asking an expert than by doing an experiment.	5	4	3	2	1
39. I find it boring to hear about new ideas.	5	4	3	2	1
40. Science lessons are a waste of time.	5	4	3	2	1
41. Talking to my friends about science after school would be boring.	5	4	3	2	1
42. I would like to teach science when I leave school.	5	4	3	2	1
43. Science helps to make life better.	5	4	3	2	1
44. Scientists do not care about their working conditions.	5	4	3	2	1
45. I would rather solve a problem by doing an experiment than be told the answer.	5	4	3	2	1
46. In science experiments, I like to use new methods which I have not used before.	5	4	3	2	1
47. I really enjoy going to science lessons.	5	4	3	2	1
48. I would enjoy having a job in a science laboratory during my school holidays.	5	4	3	2	1
49. A job as a scientist would be boring.	5	4	3	2	1
50. This country is spending too much money on science.	5	4	3	2	1
51. Scientists are just as interested in art and music as other people are.	5	4	3	2	1
52. It is better to ask a teacher the answer than to find it out by doing experiments.	5	4	3	2	1
53. I am unwilling to change my ideas when evidence shows that the ideas are poor.	5	4	3	2	1
54. The material covered in science lessons is uninteresting.	5	4	3	2	1
55. Listening to talk about science on the radio would be boring.	5	4	3	2	1
56. A job as a scientist would be interesting.	5	4	3	2	1

57. Science can help to make the world a better place in the future.	5	4	3	2	1
58. Few scientists are happily married.	5	4	3	2	1
59. I prefer to do an experiment on a topic than to read about it in science magazines.	5	4	3	2	1
Statement	**(SA)**	**(A)**	**(U)**	**(D)**	**(SD)**
60. I look forward to science lessons.	5	4	3	2	1
61. I would enjoy visiting a science museum on the weekend.	5	4	3	2	1
62. I would dislike becoming a scientist because it needs too much education.	5	4	3	2	1
63. Money used on scientific projects is wasted.	5	4	3	2	1
64. If you met a scientist, he/she would probably look like anyone else you might meet.	5	4	3	2	1
65. It is better to be told scientific facts than to find them out from experiments.	5	4	3	2	1
67. I dislike other peoples' opinions.	5	4	3	2	1
68. I would enjoy school more if there were no science lessons.	5	4	3	2	1
69. I dislike reading newspaper articles about science.	5	4	3	2	1
70. I would like to be a scientist when I leave school.	5	4	3	2	1

APPENDIX C

SCIENTIFIC LITERACY SURVEY

Scientific Literacy Survey Questions

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Directions:

1. This survey contains numerous statements about environmental science. You will be asked to answer these questions on a true or false or I do not know basis. Answer questions *honestly* about what you know concerning the content of these statements.
2. For each statement, draw a circle around the capital **"T"** for true, the capital **"F"** for false and a capital **"X"** for I do not know. **Please circle only ONE answer per statement.** Please answer the statements *honestly* and *contemplatively*. Focus on the underlined words in answering the questions. This survey will **NOT** affect your grade in this class in any way.

Statement	**(T)**	**(F)**	**(X)**
1. China uses rewards and punishments to enforce a one-child limit to each family to help with population control.	**(T)**	**(F)**	**(X)**
2. The current world population is five billion and counting.	**(T)**	**(F)**	**(X)**
3. The agricultural revolution began approximately 10,000 years ago.	**(T)**	**(F)**	**(X)**
4. The Industrial revolution began in the mid-1700s.	**(T)**	**(F)**	**(X)**
5. Doctors did not wash their hands when treating patients even for surgery until The Germ Theory of Disease was developed during the Industrial Revolution.	**(T)**	**(F)**	**(X)**
6. The population growth rate has recently started to decline.	**(T)**	**(F)**	**(X)**
7. Total fertility rates have started to increase globally.	**(T)**	**(F)**	**(X)**
8. China and Mexico are considered to be developing nations.	**(T)**	**(F)**	**(X)**
9. Better educational opportunities for women are linked to declining fertility rates.	**(T)**	**(F)**	**(X)**
10. Technology has only positive impacts on the environment.	**(T)**	**(F)**	**(X)**
Statement	**(T)**	**(F)**	**(X)**

11. DDT is a chemical that is currently used in the U.S. to kill lice for the prevention of typhoid fever and to kill mosquitoes that carry malaria.	**(T)**	**(F)**	**(X)**
12. Annually the likelihood of death is greater from being struck by lightning than by being hit by a meteorite.	**(T)**	**(F)**	**(X)**
13. The number one affliction causing deaths globally is respiratory diseases.	**(T)**	**(F)**	**(X)**
14. Malaria can only be spread by the bite of a female *Anopheles* mosquito.	**(T)**	**(F)**	**(X)**
15. Eradicating mosquitoes can also reduce the risk of cholera.	**(T)**	**(F)**	**(X)**
16. MRSA (methicillin resistant *Staphylococcus aureus)* is an example of an emerging disease.	**(T)**	**(F)**	**(X)**
17. Excessive use of alcohol may cause mental retardation and birth defects in developing embryos and fetuses.	**(T)**	**(F)**	**(X)**
18. Furniture, carpets and foam insulation in your house contains the pollutant formaldehyde and has the potential to cause respiratory inflammation and cancer.	**(T)**	**(F)**	**(X)**
19. The state and county with which you live in has a very low geologic radon potential.	**(T)**	**(F)**	**(X)**
20. Most of the top twelve persistent organic pollutants are pesticides.	**(T)**	**(F)**	**(X)**
21. Soil is a mixture of biotic and abiotic components.	**(T)**	**(F)**	**(X)**
22. In order to avoid "The Tragedy of the Commons" in the U.S. range managers help ranchers or livestock owners rotate their herds.	**(T)**	**(F)**	**(X)**
23. The largest cause of soil degradation is chemical problems.	**(T)**	**(F)**	**(X)**
24. In response to the "Dust Bowl" in the 1930's in the U.S. Congress passed the Soil Conservation Act, establishing the Soil Conservation service.	**(T)**	**(F)**	**(X)**
25. The Green revolution started recycling processes in developing nations.	**(T)**	**(F)**	**(X)**
26. The honey bee is a common pollinator whose population is declining due to pesticide us	**(T)**	**(F)**	**(X)**
27. A widely used biological pesticide is *Bacillus thuringiensis (Bt)*, a soil bacteria, that produces a protein that kills certain caterpillars and larvae of some flies and beetles.	**(T)**	**(F)**	**(X)**

Statement	**(T)**	**(F)**	**(X)**
28. The human population is growing faster global food production.	**(T)**	**(F)**	**(X)**
29. Organsims that have undergone genetic engineering are called genetically modified organisms or (GMOs).	**(T)**	**(F)**	**(X)**
30. Beef requires more feed, water, land, and energy to produce than any other animal food product that we consume.	**(T)**	**(F)**	**(X)**
31. The site of the world's worst nuclear accident occurred in Chernobyl Russia in 1986.	**(T)**	**(F)**	**(X)**
32. The most recent devastating typhoon occurred in the Philippines on December 7, 2014.	**(T)**	**(F)**	**(X)**
33. Countries with recent widespread transmission of AIDS are Guinea, Liberia and Sierra Leone.	**(T)**	**(F)**	**(X)**
34. Both developed and developing countries are working together on climate change issues.	**(T)**	**(F)**	**(X)**
35. In Philadelphia on 12-2-14 the USDA (United States Department of Agriculture) announced they will help schools purchase food from local farmers promoting healthy food choices and support for local economies.	**(T)**	**(F)**	**(X)**
36. Immigration reform in the U.S. will require illegal immigrants to pay taxes, learn English and undergo background checks before they are eligible for citizenship.	**(T)**	**(F)**	**(X)**
37. The first genetically modified food to receive approval from the FDA (food and drug administration) I the U. S. was corn.	**(T)**	**(F)**	**(X)**
38. Fracking could be blamed for an increase in earthquakes in the U.S.	**(T)**	**(F)**	**(X)**
39. The loss of rainforests on a daily basis is equivalent to 36 football fields every minute.	**(T)**	**(F)**	**(X)**
40. The first Earth Day was in 1970.	**(T)**	**(F)**	**(X)**
41. One use for genetically modified organisms is to enhance flavors of certain foods.	**(T)**	**(F)**	**(X)**
42. The FDA (Food and Drug Administration) regulates genetically modified foods.	**(T)**	**(F)**	**(X)**
43. Bananas need pesticides to prevent them from being infected with a fungus.	**(T)**	**(F)**	**(X)**
44. The most popular fruit in the world is the apple.	**(T)**	**(F)**	**(X)**
Statement	**(T)**	**(F)**	**(X)**

45. Vitamin A deficiency can lead to blindness.	**(T)**	**(F)**	**(X)**
46. The only GMOs currently available to farmers are those used for pest control.	**T)**	**(F)**	**(X)**
47. Vitamin A is added to rice because rice is a readily available food across the world.	**(T)**	**(F)**	**(X)**
48. GMO plants cannot cross fertilize with non-GMO plants.	**(T)**	**(F)**	**(X)**
49. Genetic engineering can now protect crops from harsh weather conditions.	**(T)**	**(F)**	**(X)**
50. Genetic engineering will allow us to develop crops with a lower caloric content.	**(T)**	**(F)**	**(X)**
51. GMO seeds first available commercially in the United States in 1996.	**(T)**	**(F)**	**(X)**
52. Farmers grow GMO crops to increase crop yield and increase pesticide use.	**(T)**	**(F)**	**(X)**
53. GMO crops are grown in 25 countries.	**(T)**	**(F)**	**(X)**
54. The most GMO crops are grown in Brazil.	**(T)**	**(F)**	**(X)**
55. 70 % percent of foods in U.S. supermarkets are estimated to contain one ingredient that is derived from GMO crops?	**(T)**	**(F)**	**(X)**
56. Soybeans are the most popular GMO crop cultivated in the United States.	**(T)**	**(F)**	**(X)**
57. Genetically manipulating plants by adding multiple genes for the same or different traits, such as higher yield and herbicide tolerance is called trait stacking.	**(T)**	**(F)**	**(X)**
58. The rose is the flower that leant a gene to rice to synthesize the production of beta carotene in "golden rice".	**(T)**	**(F)**	**(X)**
59. A concern over GMO use is a lack of testing of GMO crop side effects.	**(T)**	**(F)**	**(X)**
60. Genetic manipulation in humans may result as from consumption of GMO foods.	**(T)**	**(F)**	**(X)**

APPEDIX D

CONFIDENCE SURVEY

Environmental Science- Student Confidence Survey

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Now that you have completed some course work in environmental science this year; how confident do you feel that you will be able to do the following successfully by the end of this course and or in the future? (Circle the most accurate response.)

	How Confident Do You Feel? (circle one)			
1. Feel comfortable reading the environmental Science textbook.	Very	Somewhat	Not Very	Not at all
2. Completing chapter homework to prepare for quizzes and tests.	Very	Somewhat	Not Very	Not at all
3. Completing coordinating Chapter worksheets to reinforce content material.	Very	Somewhat	Not Very	Not at all
4. Analyzing data at the end of chapters.	Very	Somewhat	Not Very	Not at all
5. Answering critical thinking questions at the end of chapters.	Very	Somewhat	Not Very	Not at all
6. Viewing documentaries and completing coordinating worksheets.	Very	Somewhat	Not Very	Not at all
7. Researching, summarizing, and writing reaction paragraphs on current event environmental science issues.	Very	Somewhat	Not Very	Not at all

8. Working collaboratively on case studies that present with real world environmental science issues.	Very	Somewhat	Not Very	Not at all

APPENDIX E

CONFIDENCE AND ATTITUDE SURVEY

Participation in this research is voluntary and participation or non-participation will NOT affect a student's grades or class standing in any way.

Please complete the survey honestly. The purpose of this survey is to gather your opinions regarding this approach to learning.
Please use the following scale: 1 (strongly disagree), 2 (disagree), 3 (indifferent), 4 (agree), and 5 (strongly agree).

1. I enjoy learning about environmental science.	**1 2 3 4 5**
2. I like learning environmental science from the textbook.	**1 2 3 4 5**
3. I like learning environmental science through classroom activities.	**1 2 3 4 5**
4. Environmental science activities increase my motivation to learn.	**1 2 3 4 5**
5. I participated more in this unit than I normally do.	**1 2 3 4 5**
6. I am more motivated to learn and participate because I could relate to the issues that we learned about in class.	**1 2 3 4 5**
7. Activities related to my life help me to better understand environmental science concepts.	**1 2 3 4 5**
8. Case studies help me better understand environmental science concepts.	**1 2 3 4 5**
9. Case studies help me learn about environmental science issues beyond the textbook.	**1 2 3 4 5**
10. Documentaries help me better understand environmental science concepts.	**1 2 3 4 5**
11. Documentaries help me learn about environmental science issues beyond the textbook.	**1 2 3 4 5**
12. Current events helps me better understand environmental science concepts.	**1 2 3 4 5**
13. Current events help me learn about environmental science issues beyond the textbook.	**1 2 3 4 5**

14. Which method of learning helps you understand environmental science issues the best? Explain

_____
_____
_____
_____
_____

15. Which method of learning helps you correlate content material to real world issues? Explain.

_____
_____
_____
_____

16. Do you think you are scientifically literate? Explain

_____
_____
_____
_____

17. Which method of learning do you think best helps you to become scientifically literate? Explain.

_____
_____
_____
_____
_____
_____

18. How important is it for you to become scientifically literate? Explain.

_____
_____
_____
_____
_____
_____

APPENDIX F

UNIT ASSESSMENTS

Environmental Science-CP-Chapter 8-Human Population

Multiple Choice

Identify the choice that best completes the statement or answers the question. **Circle** the answer and **write the letter on the line** provided.

____ 1. In what year did the human population reach 1 billion people?
a. 300
b. 1200
c. 1800
d. 2000

____ 2. In recent years, the human population has
a. increased exponentially.
b. decreased exponentially.
c. decreased slowly.
d. increased slowly.

____ 3. The average number of years an individual is predicted to live is called
a. carrying capacity.
b. life expectancy.
c. growth rate.
d. demography.

____ 4. The number of organisms that an environment can support is called the
a. life expectancy.
b. demography.
c. carrying capacity.
d. growth rate.

____ 5. Which area would have the lowest population density?
a. seacoast in Europe
b. river in China
c. tundra in Russia
d. suburb in the U.S.A.

____ 6. The amount of people living in a given area is described as population
a. morality.
b. expectancy.

c. rate.
d. density.

____ 7. Which factor(s) help increase total fertility rates?
a. needing extra help on farms
b. government programs supporting older adults
c. more children surviving childhood
d. one-child policies

____ 8. What does the replacement fertility rate depend on the most?
a. population growth
b. demography
c. total fertility rate
d. death rate

____ 9. What can be inferred about an area that has an age structure diagram with a pyramid shape?
a. The population is likely to decrease in the future.
b. There is a high proportion of older people to younger people.
c. There is a high population growth rate.
d. There is a low population growth rate.

____ 10. What could be inferred about an area that has an age structure diagram with a "barrel" shape (thicker in the middle, narrower on the top and bottom)?
a. There is low population growth.
b. The population is likely to increase in the future.
c. There is a high proportion of young people to older people.
d. There is high population growth.

____ 11. The number of males compared to females in a population is the
a. age structure.
b. sex ratio.
c. total fertility rate.
d. demography.

____ 12. The model used to explain the reason that some industrialized nations have experienced a large change in birthrates and death rates is called the
a. demographic transition model.
b. replacement fertility model.
c. Industrial Revolution model.
d. life expectancy model.

____ 13. Which stage of the demographic transition is characterized by conditions that have defined most of human history?
   a. industrial
   b. pre-industrial
   c. post-industrial
   d. transitional

____ 14. Which stage of the demographic transition has the highest level of population growth?
   a. industrial
   b. transitional
   c. pre-industrial
   d. post-industrial

____ 15. Which of the following regions is developed?
   a. China
   b. Mexico
   c. Australia
   d. eastern Europe

Modified True/False
Indicate whether the statement is true or false. If false, change the identified word or phrase to make the statement true.

____ 1. The Industrial Revolution happened about 200 to 300 years ago. _____

____ 2. A population with fewer younger people than older people will likely decrease in the future. _____

____ 3. More people live in developing nations than live in developed nations. _____

____ 4. Humans have a(n) minor impact on their environment. _____

____ 5. Individuals from affluent societies tend to have smaller ecological footprints than people from poor societies. _____

Completion
Complete each statement. ***Not*** *all words will be used.*

Word Bank

Demography **Developed** **Developing** **(Fertility Rate)**
(Quality of Life) **(Infant Mortality)** **(Replacement (Fertility)**

1. The number of babies out of 1,000 that die during their first year of life is called _____.

2. The study of human population statistics is called _____.

3. The average number of children a female member of a population has during her lifetime is the population's total _____.

4. The term _____ nation refers to nations with moderate or low income.

5. _____ refers to how well an individual lives.

Short Answer *(Answer **each** of the following questions.)*

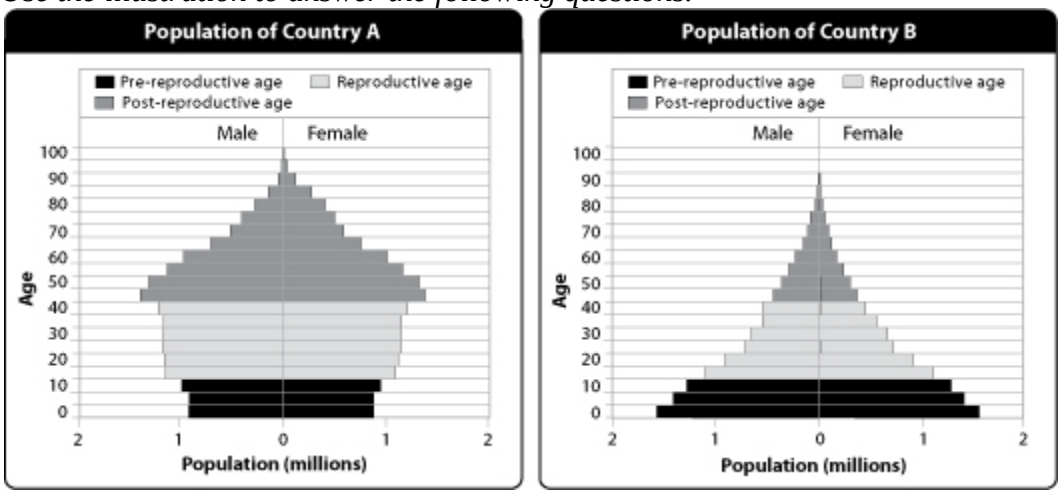
1. How did the Industrial Revolution affect agriculture?

2. How are population size, density, and distribution like "snapshots"?

3. What was one of the negative consequences of the Industrial Revolution?

Science Skills (*Answer **each** of the following questions.)*

Use the illustration to answer the following questions.



1. Which nation has a greater population growth rate? How can you tell?

2. What inference can you make about Nation *A*'s population growth?

3. Do you think the diagram for India would look more like the graph for Nation *A* or Nation *B*?

Environmental Science-CP-Chapter 8-Human Population
Answer Section

MULTIPLE CHOICE

1. ANS: C PTS: 1 DIF: L2 REF: p. 228
   OBJ: 8.1.1 Describe how technological advances have contributed to human population growth.
   STA: PA.5f | PA.5l | PA.7a BLM: knowledge

2. ANS: A PTS: 1 DIF: L2 REF: p. 230
   OBJ: 8.1.2 Explain recent trends in population growth. BLM: knowledge

3. ANS: B PTS: 1 DIF: L2 REF: p. 230
   OBJ: 8.1.2 Explain recent trends in population growth. BLM: comprehension

4. ANS: C PTS: 1 DIF: L2 REF: p. 231
   OBJ: 8.1.2 Explain recent trends in population growth. BLM: comprehension

5. ANS: C PTS: 1 DIF: L2 REF: p. 232
   OBJ: 8.1.3 Identify characteristics of human population that are studied by demographers.
   BLM: application

6. ANS: D PTS: 1 DIF: L2 REF: p. 232
   OBJ: 8.1.3 Identify characteristics of human population that are studied by demographers.
   BLM: comprehension

7. ANS: A PTS: 1 DIF: L2 REF: p. 235
   OBJ: 8.2.1 Describe total fertility rates and replacement fertility.
   BLM: application

8. ANS: D PTS: 1 DIF: L2 REF: p. 235
   OBJ: 8.2.1 Describe total fertility rates and replacement fertility.
   BLM: comprehension

9. ANS: C PTS: 1 DIF: L2 REF: p. 236
   OBJ: 8.2.2 Explain how the age structure and sex ratio of a population define its potential for growth. BLM: application

10. ANS: A PTS: 1 DIF: L2 REF: p. 236
    OBJ: 8.2.2 Explain how the age structure and sex ratio of a population define its potential for growth. BLM: application

11. ANS: B PTS: 1 DIF: L2 REF: p. 237
    OBJ: 8.2.2 Explain how the age structure and sex ratio of a population define its potential for growth. BLM: comprehension

12. ANS: A PTS: 1 DIF: L1 REF: p. 238
OBJ: 8.2.3 Describe the demographic transition. BLM: knowledge

13. ANS: B PTS: 1 DIF: L2 REF: p. 238
OBJ: 8.2.3 Describe the demographic transition. BLM: application

14. ANS: B PTS: 1 DIF: L2 REF: p. 239
OBJ: 8.2.3 Describe the demographic transition. BLM: application

15. ANS: C PTS: 1 DIF: L2 REF: p. 240
OBJ: 8.2.4 Discuss social factors that affect population growth.
BLM: comprehension

MODIFIED TRUE/FALSE

1. ANS: T PTS: 1 DIF: L1
REF: p. 229
OBJ: 8.1.1 Describe how technological advances have contributed to human population growth.
STA: PA.5f | PA.5l | PA.7a BLM: knowledge

2. ANS: T PTS: 1 DIF: L2
REF: p. 236
OBJ: 8.2.2 Explain how the age structure and sex ratio of a population define its potential for growth. BLM: application

3. ANS: T PTS: 1 DIF: L2
REF: p. 240 OBJ: 8.2.4 Discuss social factors that affect population growth.
BLM: knowledge

4. ANS: F, enormous

PTS: 1 DIF: L1 REF: p. 242
OBJ: 8.3.1 Describe how humans impact their environments. STA: PA.7n | PA.7a
BLM: comprehension

5. ANS: F, larger

PTS: 1 DIF: L2 REF: p. 242
OBJ: 8.3.1 Describe how humans impact their environments. STA: PA.7n | PA.7a
BLM: application

COMPLETION

1. ANS: infant mortality.

PTS: 1 DIF: L2 REF: p. 230
OBJ: 8.1.2 Explain recent trends in population growth. BLM: comprehension

2. ANS: demography

PTS: 1 DIF: L2 REF: p. 232
OBJ: 8.1.3 Identify characteristics of human population that are studied by demographers.
BLM: comprehension

3. ANS: fertility rate

PTS: 1 DIF: L2 REF: p. 235
OBJ: 8.2.1 Describe total fertility rates and replacement fertility.
BLM: comprehension

4. ANS: developing

PTS: 1 DIF: L2 REF: p. 240
OBJ: 8.2.4 Discuss social factors that affect population growth.
BLM: comprehension

5. ANS: Quality of life

PTS: 1 DIF: L2 REF: p. 246
OBJ: 8.3.1 Describe how humans impact their environments. STA: PA.7n | PA.7a
BLM: comprehension

SHORT ANSWER

1. ANS:
The invention of large machines allowed people to grow food in mass quantities, pesticides were developed to protect crops, and fertilizers were invented to help food grow more abundantly.

PTS: 1 DIF: L2 REF: p. 229
OBJ: 8.1.1 Describe how technological advances have contributed to human population growth.
STA: PA.5f | PA.5l | PA.7a BLM: comprehension

2. ANS:
They give demographers a “picture” of what the entire human population looks like at a particular moment in time.

PTS: 1 DIF: L2 REF: p. 233
OBJ: 8.1.3 Identify characteristics of human population that are studied by demographers.
BLM: analysis

3. ANS:
   It caused ever-increasing resource consumption and pollution, which had a negative effect on the environment.

   PTS: 1 DIF: L2 REF: p. 242
   OBJ: 8.3.1 Describe how humans impact their environments. STA: PA.7n | PA.7a
   BLM: application

SCIENCE SKILLS

1. ANS:
   Nation *B* has a greater population growth rate because its graph has a pyramid shape with more young people than old people.

   PTS: 1 DIF: L2 REF: p. 236
   OBJ: 8.2.2 Explain how the age structure and sex ratio of a population define its potential for growth. BLM: analysis

2. ANS:
   Nation *A*'s population growth is relatively low because it has fewer young people (pre-reproductive age) than older people (reproductive age).

   PTS: 1 DIF: L2 REF: p. 236
   OBJ: 8.2.2 Explain how the age structure and sex ratio of a population define its potential for growth. BLM: analysis

3. ANS:
   Sample: It would look more like Nation *B*'s, because India's population is also undergoing rapid growth.

   PTS: 1 DIF: L3 REF: p. 236
   OBJ: 8.2.2 Explain how the age structure and sex ratio of a population define its potential for growth. BLM: evaluation

Environmental Science-CP-Chapter 9-Environmental Health

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. Viruses, bacteria, and other organisms in the environment that harm human health are classified as
a. biological hazards.
b. social hazards.
c. chemical hazards.
d. physical hazards.

____ 2. Toxicology deals primarily with what types of hazards?
a. biological and social
b. both chemical and physical
c. human-made
d. natural disasters

____ 3. The process of measuring the chance that an environmental hazard will cause harm is called
a. toxicology.
b. epidemiology.
c. dose-response relationship.
d. risk assessment.

____ 4. Which of the following is an example of a social hazard that cannot easily be controlled?
a. smoking cigarettes
b. pollution from a factory near your school
c. lack of exercise
d. a high-fat diet

____ 5. What do asbestos, radon, volatile organic compounds, carbon monoxide, and lead all have in common?
a. They are chemical hazards that can be found indoors.
b. They are highly dangerous carcinogens.
c. Exposure to them cannot be prevented.
d. They are unnatural and made only by humans.

____ 6. Environmental hazards that result from where we live, our jobs, or our lifestyle choices are called
a. physical hazards.
b. chemical hazards.

c. biological hazards.
d. social hazards.

____ 7. Epidemiology deals primarily with what type of hazards?
a. physical
b. chemical
c. social
d. biological

____ 8. Which of the following factors causes different people to respond differently to environmental hazards?
a. sex
b. weight
c. health issues
d. all of the above

____ 9. A vector is a(n)
a. kind of pathogen.
b. organism that carries pathogens.
c. type of infectious disease.
d. type of emerging disease.

____ 10. The H1N1 (swine) flu first appeared in Mexico in March of 2009. By June, it had spread to 70 different countries, infecting nearly 30,000 people. H1N1 is an example of a(n)
a. chemical hazard.
b. emerging disease.
c. social hazard.
d. vector.

____ 11. Which of the following is an example of a social hazard that can generally be controlled?
a. smoking cigarettes
b. emerging diseases
c. pollution from a garbage dump near your home
d. natural disasters

____ 12. A substance's toxicity depends not just on what it is, but also
a. on whether it was produced naturally or by people.
b. what its scientific name is.

c. how much of it a person is exposed to.
d. where it is found in the environment.

____ 13. Young children are frequently tested for what chemical hazard that was used in paints and pipes in many homes and buildings?
a. radon
b. asbestos
c. carbon monoxide
d. lead

____ 14. Each step up the food chain, concentrations of toxicants can be greatly multiplied in a process called
a. biomagnification.
b. toxicology.
c. risk assessment.
d. epidemiology.

____ 15. Mudflows and ash clouds are some of the many dangers of
a. storms.
b. tsunamis.
c. earthquakes.
d. volcanic eruptions.

Modified True/False
Indicate whether the statement is true or false. If false, change the identified word or phrase to make the statement true.

____ 1. A person can die from drinking <u>too much</u> water, too quickly. _____

____ 2. During a tornado, the safest place to be is <u>outdoors</u>. _____

____ 3. The flu virus, the bacterium that causes strep throat, and even pet dander that may cause allergies are all examples of <u>social</u> hazards. _____

____ 4. When new diseases first emerge, humans usually have <u>many</u> medicines and vaccines to control them. _____

____ 5. Some chemical hazards disrupt the <u>endocrine</u> system, the body system that sends and receives chemical signals, called hormones. _____

Completion

*Complete each statement. **Not** all the words will be used.*

Physical Chemical Genetic Autoimmune
Hurricane Tornado Volcano
Allergens Epidemiology Neurotoxin

1. Some ongoing natural phenomena, such as ultraviolet (UV) radiation from sunlight, represent _____ hazards.

2. Some diseases, such as breast cancer, can be traced to _____ factors in addition to environmental hazards.

3. Substances known as _____ cause the immune system to overreact to a normally harmless substance.

4. A(n) _____ is an opening in the Earth's crust through which molten lava, ash, and gases are ejected.

5. A(n) _____ is a type of windstorm in which a funnel of rotating air drops down from a storm cloud and touches Earth's surface.

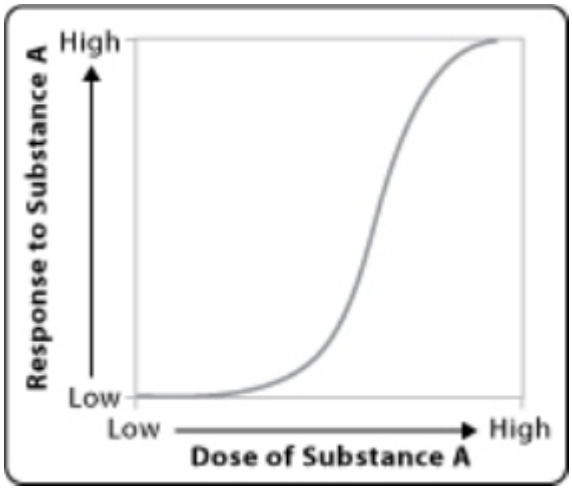
Short Answer

1. How can water treatment facilities help stop the spread of infectious diseases? ***Explain.***
2. What is meant by the phrase "the dose makes the poison"? ***Explain.***

3. Name ***two*** ways that have humans enabled emerging diseases to spread more rapidly?

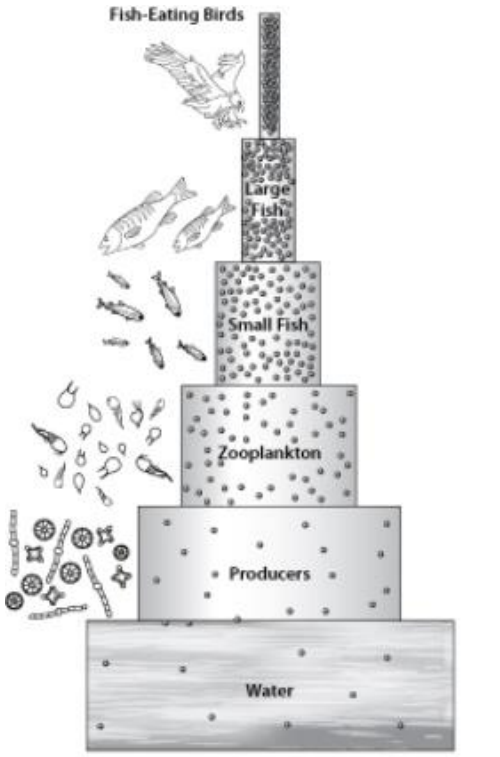
Science Skills

Use the graph to answer the following questions.



1. What is the name of the relationship shown in this graph?
2. What type of scientist would have the most use for a graph like this?

Use the illustration to answer the following questions.



In this diagram, the small dots represent the peticide DDT.

3. What happens to DDT as it moves in this diagram? ***Explain.***

Environmental Science-CP-Chapter 9-Environmental Health
Answer Section

MULTIPLE CHOICE

1. ANS: A PTS: 1 DIF: L1 REF: p. 256
   OBJ: 9.1.1 List the types of environmental health hazards. STA: PA.1a | PA.1b | PA.1c
   BLM: comprehension

2. ANS: B PTS: 1 DIF: L3 REF: p. 258
   OBJ: 9.1.2 Compare and contrast epidemiology and toxicology.
   BLM: application

3. ANS: D PTS: 1 DIF: L1 REF: p. 260
   OBJ: 9.1.4 Discuss risk assessment. STA: PA.6e BLM: comprehension

4. ANS: B PTS: 1 DIF: L2 REF: p. 266
   OBJ: 9.2.3 Differentiate between social hazards that are lifestyle choices and those that cannot be controlled. BLM: evaluation

5. ANS: A PTS: 1 DIF: L2 REF: p. 270
   OBJ: 9.3.3 List some indoor chemical hazards. STA: PA.6a | PA.6b | PA.1e
   BLM: comprehension

6. ANS: D PTS: 1 DIF: L2 REF: p. 256
   OBJ: 9.1.1 List the types of environmental health hazards. STA: PA.1a | PA.1b | PA.1c
   BLM: comprehension

7. ANS: D PTS: 1 DIF: L2 REF: p. 258
   OBJ: 9.1.2 Compare and contrast epidemiology and toxicology.
   BLM: application

8. ANS: D PTS: 1 DIF: L1 REF: p. 259
   OBJ: 9.1.3 Describe the reasons why individuals respond differently to the same environmental health hazards. STA: PA.1a | PA.6a BLM: knowledge

9. ANS: B PTS: 1 DIF: L1 REF: p. 261
   OBJ: 9.2.1 Describe how infectious diseases spread. BLM: knowledge

10. ANS: B PTS: 1 DIF: L2 REF: p. 263
    OBJ: 9.2.2 Explain why emerging diseases are important to monitor and control.
    STA: PA.6d | PA.6e BLM: application

11. ANS: A PTS: 1 DIF: L2 REF: p. 266

OBJ: 9.2.3 Differentiate between social hazards that are lifestyle choices and those that cannot be controlled. BLM: evaluation

12. ANS: C PTS: 1 DIF: L2 REF: p. 267
OBJ: 9.3.1 Explain what makes chemicals hazardous. STA: PA.6a
BLM: comprehension

13. ANS: D PTS: 1 DIF: L1 REF: p. 272
OBJ: 9.3.3 List some indoor chemical hazards. STA: PA.6a | PA.6b | PA.1e
BLM: knowledge

14. ANS: A PTS: 1 DIF: L2 REF: p. 275
OBJ: 9.3.5 Describe biomagnification. STA: PA.6a BLM: comprehension

15. ANS: D PTS: 1 DIF: L2 REF: p. 279
OBJ: 9.4.2 Discuss how volcanoes affect human lives and property.
STA: PA.2g BLM: knowledge

MODIFIED TRUE/FALSE

1. ANS: T PTS: 1 DIF: L2
REF: p. 267 OBJ: 9.3.1 Explain what makes chemicals hazardous.
STA: PA.6a BLM: comprehension

2. ANS: F, indoors

PTS: 1 DIF: L2 REF: p. 280
OBJ: 9.4.3 Describe tornadoes, hurricanes, and thunderstorms. STA: PA.2g
BLM: evaluation

3. ANS: F, biological

PTS: 1 DIF: L2 REF: p. 256
OBJ: 9.1.1 List the types of environmental health hazards. STA: PA.1a | PA.1b | PA.1c
BLM: application

4. ANS: F, few or no

PTS: 1 DIF: L2 REF: p. 263
OBJ: 9.2.2 Explain why emerging diseases are important to monitor and control.
STA: PA.6d | PA.6e BLM: application

5. ANS: T PTS: 1 DIF: L2
REF: p. 266

OBJ: 9.2.3 Differentiate between social hazards that are lifestyle choices and those that cannot be controlled. BLM: comprehension

COMPLETION

1. ANS: physical

   PTS: 1 DIF: L3 REF: p. 257
   OBJ: 9.1.1 List the types of environmental health hazards. STA: PA.1a | PA.1b | PA.1c
   BLM: application

2. ANS: genetic

   PTS: 1 DIF: L3 REF: p. 259
   OBJ: 9.1.3 Describe the reasons why individuals respond differently to the same environmental health hazards. STA: PA.1a | PA.6a BLM: comprehension

3. ANS: allergens

   PTS: 1 DIF: L2 REF: p. 269
   OBJ: 9.3.2 Discuss how chemical hazards affect human health. STA: PA.6a
   BLM: knowledge

4. ANS: volcano

   PTS: 1 DIF: L1 REF: p. 279
   OBJ: 9.4.2 Discuss how volcanoes affect human lives and property.
   STA: PA.2g BLM: knowledge

5. ANS: tornado

   PTS: 1 DIF: L1 REF: p. 280
   OBJ: 9.4.3 Describe tornadoes, hurricanes, and thunderstorms. STA: PA.2g
   BLM: knowledge

SHORT ANSWER

1. ANS:
   Some diseases are passed to humans in water contaminated by human feces. Treating contaminated water before it is used by humans can stop the spread of the disease.

   PTS: 1 DIF: L3 REF: p. 263
   OBJ: 9.2.1 Describe how infectious diseases spread. BLM: analysis

2. ANS:
   Any chemical can be harmful in large enough amounts.

   PTS: 1 DIF: L3 REF: p. 267
   OBJ: 9.3.1 Explain what makes chemicals hazardous. STA: PA.6a
   BLM: analysis

3. ANS:
   by increasing their mobility around the globe, and by altering the environment

   PTS: 1 DIF: L2 REF: p. 264
   OBJ: 9.2.2 Explain why emerging diseases are important to monitor and control.
   STA: PA.6d | PA.6e BLM: application

SCIENCE SKILLS

1. ANS:
   a dose-response relationship

   PTS: 1 DIF: L2 REF: p. 258
   OBJ: 9.1.1 List the types of environmental health hazards. STA: PA.1a | PA.1b | PA.1c
   BLM: application

2. ANS:
   toxicologist

   PTS: 1 DIF: L3 REF: p. 258
   OBJ: 9.1.1 List the types of environmental health hazards. STA: PA.1a | PA.1b | PA.1c
   BLM: evaluation

3. ANS:
   it becomes more concentrated at each step up the food chain

   PTS: 1 DIF: L2 REF: p. 275
   OBJ: 9.3.5 Describe biomagnification. STA: PA.6a BLM: analysis

Environmental Science Test-CP Chapter 12- Soil and Agriculture

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. After a catastrophe, soil formation is the first step in
a. primary succession.
b. secondary succession.
c. a climax community.

____ 2. A rock containing iron turns red as its surface is exposed to air and water over time. This is an example of
a. physical weathering.
b. chemical weathering.
c. primary succession.
d. decomposition.

____ 3. Most of the nutrients in soil come from
a. chemical weathering.
b. mechanical weathering.
c. erosion.
d. decomposition.

____ 4. Deterioration of the soil's fertility and ability to provide ecosystem services is called
a. erosion.
b. soil degradation.
c. soil pollution.
d. succession.

____ 5. Watering crops by way of human-constructed structures is known as
a. precipitation.
b. irrigation.
c. salinization.
d. fertilization.

____ 6. Agriculture most likely began
a. 10,000 years ago in the Middle East.
b. 200,000 years ago in Africa.
c. 15,000 years ago in China.

d. 150,000 years ago in Egypt.

____ 7. Genetic engineering relies on placing a gene that codes for a desired trait into the _____ of a different organism from the organism where the gene was originally harvested.
a. protein
b. amino acid
c. helix
d. genome

____ 8. Your friend tells you she's decided not to use pesticides or synthetic chemicals on her farm; instead she'll rely on composting and biological pest control. She is practicing
a. industrial agriculture.
b. monoculture.
c. organic agriculture.
d. sustainable agriculture.

____ 9. Sustainable agriculture is important because while human population continues to grow, one of the following will not.
a. animal population
b. arable land
c. food production
d. GM crops

____ 10. What event enabled the evolution of agriculture?
a. warming climate due to volcanic eruptions in Indonesia
b. sudden growth in human population
c. a decrease in natural prey species such as large hooved mammals
d. a warming climate ending an ice age

____ 11. A large area of cropland seeded with one crop is a(n)
a. monoculture.
b. polyculture.
c. organic practice.
d. traditional farming technique.

____ 12. One of the problematic side effects of pesticide use is the fact that
a. pesticides kill important pollinator insects as well as insect pests.
b. pesticides reduce crop yields, sometimes up to 50 percent.

c. pesticide manufacturers must create new pesticides every year, requiring large investments.
d. farmers must apply pesticides every year.

____ 13. A farmer has an infestation of aphids and greenflies. He introduces ladybugs, which prey on aphids, and uses a limited dose of a pesticide to deal with the flies. The farmer's approach to insect pests is
a. chemical control.
b. biological control.
c. integrated pest management.
d. organic pest management.

____ 14. The average food item in the United States travels 2400 km to reach the buyer. One alternative to this energy-inefficient practice is
a. treating the food with preservative chemicals.
b. buying locally produced food.
c. buying organic food.
d. buying GM food.

____ 15. GM foods are engineered to resist herbicides so that
a. humans won't be put at health risk from pesticides.
b. insect pests will avoid the crops.
c. the crops will grow more efficiently.
d. farmers can use heavier doses of pesticides for weeds without killing the crop plants.

Modified True/False
Indicate whether the statement is true or false. If false, change the identified word or phrase to make the statement true.

____ 1. <u>Traditional</u> agriculture is best defined by its reliance on fossil fuels and mechanization. _____

____ 2. People who want to protect land, water, and wildlife, and prevent pesticides from entering their own bodies, should buy <u>GM</u> food. _____

____ 3. The two types of weathering are mechanical and <u>chemical</u>. _____

____ 4. Food-growing that uses no synthetic fertilizers or pesticides is industrial agriculture. _____

____ 5. Heavy use of antibiotics in animal feedlots may lead to human health risks when bacteria develop resistance. _____

Completion
Complete each statement.

Antibiotics (Crop Diversity) Weathering Terracing Salinization Malnutrition Starvation Aquaculture (Selective Breeding) (Genetically Modified)

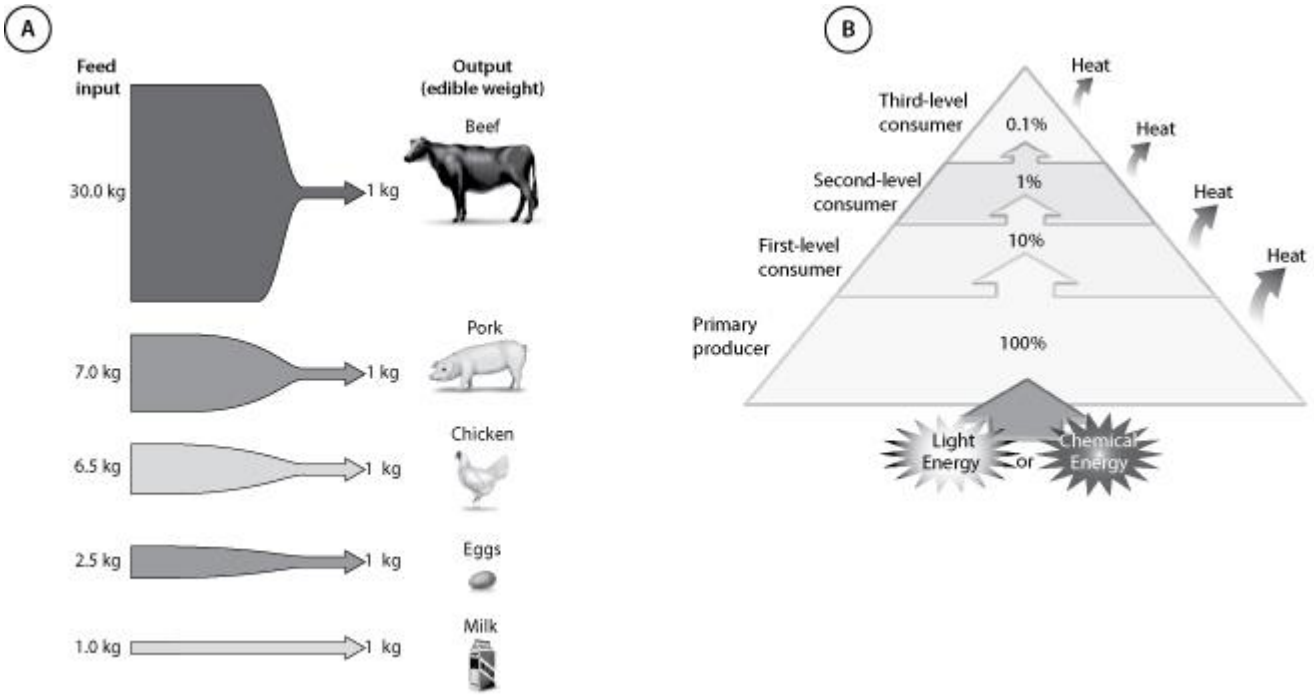
1. _____ is the result of a buildup of salts in the top layers of soil after excessive irrigation carries dissolved salts to the surface.
2. Modern crops, fruits, vegetables, and livestock are the result of _____.
3. Rain, strong winds, and the exposure to compounds in water and air are examples of _____.
4. People who lack adequate food frequently suffer from _____.
5. A(n) _____ organism produces genes for a trait that is not originally part of its species' gene code.

Short Answer

1. Discuss at least *two* of the effects of overgrazing on rangeland, and how these might be mitigated.
2. A farmer realizes that her fields are highly saline. Name *two* solutions that she might try?
3. Explain *two* benefits of the Green Revolution.

Science Skills

Use the illustration to answer the following questions.



1. In Chart *A*, which is the most efficient source of animal protein?

2. Chart *B* illustrates energy transfer and trophic structure in a natural ecosystem. If this was an agriculture ecosystem, at which level would humans be located?

Environmental Science Test-CP Chapter 12- Soil and Agriculture

Answer Section

MULTIPLE CHOICE

1. ANS: A PTS: 1 DIF: L2 REF: p. 353
   OBJ: 12.1.1 Explain three processes by which soil forms. BLM: application

2. ANS: B PTS: 1 DIF: L2 REF: p. 354
   OBJ: 12.1.1 Explain three processes by which soil forms. BLM: application

3. ANS: D PTS: 1 DIF: L2 REF: p. 354
   OBJ: 12.1.1 Explain three processes by which soil forms. BLM: analysis

4. ANS: B PTS: 1 DIF: L1 REF: p. 358
   OBJ: 12.2.1 Describe some practices that can lead to soil erosion and some that can prevent it.
   STA: PA.1j BLM: comprehension

5. ANS: B PTS: 1 DIF: L1 REF: p. 364
   OBJ: 12.2.4 Explain how irrigation and pesticide use can cause soil pollution.
   STA: PA.7g | PA.7p | PA.6b BLM: comprehension

6. ANS: A PTS: 1 DIF: L1 REF: p. 365
   OBJ: 12.3.1 Discuss the beginnings of agriculture. STA: PA.4a
   BLM: comprehension

7. ANS: D PTS: 1 DIF: L1 REF: p. 375
   OBJ: 12.4.2 Discuss genetically modified food. STA: PA.7n
   BLM: comprehension

8. ANS: C PTS: 1 DIF: L2 REF: p. 282
   OBJ: 12.4.4 Discuss sustainable agriculture. STA: PA.5l | PA.7k | PA.7l
   BLM: application

9. ANS: B PTS: 1 DIF: L3 REF: p. 374 | p. 381
   OBJ: 12.4.1 Explain why the world needs to grow more food and to grow it sustainably.
   STA: PA.4d | PA.5l BLM: synthesis

10. ANS: D PTS: 1 DIF: L2 REF: p. 365
    OBJ: 12.3.1 Discuss the beginnings of agriculture. STA: PA.4a
    BLM: analysis

11. ANS: A PTS: 1 DIF: L1 REF: p. 367
OBJ: 12.3.2 Explain the importance of industrial agriculture and the green revolution.
STA: PA.4a | PA.4d BLM: comprehension

12. ANS: A PTS: 1 DIF: L2 REF: p. 371
OBJ: 12.3.4 Explain the importance of pollinators to agriculture.
STA: PA.7k BLM: analysis

13. ANS: C PTS: 1 DIF: L2 REF: p. 369
OBJ: 12.3.3 Identify different types of pest control. STA: PA.7p | PA.7l
BLM: application

14. ANS: B PTS: 1 DIF: L2 REF: p. 383
OBJ: 12.4.4 Discuss sustainable agriculture. STA: PA.5l | PA.7k | PA.7l
BLM: analysis

15. ANS: D PTS: 1 DIF: L2 REF: p. 376
OBJ: 12.4.2 Discuss genetically modified food. STA: PA.7n
BLM: analysis

MODIFIED TRUE/FALSE

1. ANS: F, Industrial

PTS: 1 DIF: L2 REF: p. 367
OBJ: 12.3.2 Explain the importance of industrial agriculture and the green revolution.
STA: PA.4a | PA.4d BLM: analysis

2. ANS: F, organic

PTS: 1 DIF: L2 REF: p. 382
OBJ: 12.4.4 Discuss sustainable agriculture. STA: PA.5l | PA.7k | PA.7l
BLM: application

3. ANS: T PTS: 1 DIF: L1
REF: p. 354 OBJ: 12.1.1 Explain three processes by which soil forms.
BLM: knowledge

4. ANS: F, organic agriculture.

PTS: 1 DIF: L1 REF: p. 382

OBJ: 12.4.4 Discuss sustainable agriculture. STA: PA.5l | PA.7k | PA.7l
BLM: knowledge

5. ANS: T PTS: 1 DIF: L2
REF: p. 379
OBJ: 12.4.3 Describe the advantages and disadvantages of industrial food production.
STA: PA.4d | PA.4i BLM: analysis

COMPLETION

1. ANS: Salinization

PTS: 1 DIF: L1 REF: p. 364
OBJ: 12.2.4 Explain how irrigation and pesticide use can cause soil pollution.
STA: PA.7g | PA.7p | PA.6b BLM: comprehension

2. ANS: selective breeding.

PTS: 1 DIF: L2 REF: p. 366
OBJ: 12.3.1 Discuss the beginnings of agriculture. STA: PA.4a
BLM: application

3. ANS: weathering

PTS: 1 DIF: L2 REF: p. 354
OBJ: 12.1.2 Describe the horizons that make up a soil profile. BLM: application

4. ANS: malnutrition

PTS: 1 DIF: L1 REF: p. 373
OBJ: 12.4.1 Explain why the world needs to grow more food and to grow it sustainably.
STA: PA.4d | PA.5l BLM: comprehension

5. ANS:
genetically modified
GM

PTS: 1 DIF: L1 REF: p. 379
OBJ: 12.4.3 Describe the advantages and disadvantages of industrial food production.
STA: PA.4d | PA.4i BLM: comprehension

SHORT ANSWER

1. ANS:
   Overgrazing can result in soil compaction, reduction in native plant species, and increase in invasive species. The productivity of the land may decline. In order to maintain healthy rangeland, the numbers of animals should be limited to the rangeland's carrying capacity, and the animals should be moved around frequently.

   PTS: 1 DIF: L2 REF: p. 360
   OBJ: 12.2.1 Describe some practices that can lead to soil erosion and some that can prevent it.
   STA: PA.1j BLM: analysis

2. ANS:
   She would do best to prevent further salinization by planting crops that do not require a great deal of water, especially if the farm is in a dry region. She should also irrigate efficiently so that the water goes to the crops' roots.

   PTS: 1 DIF: L2 REF: p. 364 BLM: application

3. ANS:
   The Green Revolution saved millions of lives by increasing crop yields and updating agricultural practices around the world. Many nations have increased food security because of the Green Revolution, and the increased efficiency of agriculture has saved some ecosystems.

   Industrial agriculture requires 7000 percent more energy than traditional agriculture, however, and increased use of fertilizers and pesticides has contaminated many waterways and harmed wildlife. Intensive agriculture has worsened erosion.

   PTS: 1 DIF: L2 REF: p. 368
   OBJ: 12.3.2 Explain the importance of industrial agriculture and the green revolution.
   STA: PA.4a | PA.4d BLM: analysis

SCIENCE SKILLS

1. ANS:
   milk

   PTS: 1 DIF: L2 REF: p. 381
   OBJ: 12.4.3 Describe the advantages and disadvantages of industrial food production.
   STA: PA.4d | PA.4i BLM: application

2. ANS:
   Humans would be at the top.

PTS: 1 DIF: L3 REF: p. 381
OBJ: 12.4.4 Discuss sustainable agriculture. STA: PA.5l | PA.7k | PA.7l
BLM: synthesis

APPENDIX G

STUDENT INTERVIEWS

Student Interview Questions

This interview contains numerous questions about science. You will be asked what you think about and answer these questions. There are **NO** *right* or *wrong* answers. Answer each question *honestly* and *thoughtfully*. Your answers to these questions will **NOT** affect your grade in this class.

1- What are your feelings about learning science and science in our world? Explain.
2- Do you think that learning science is important even if you are not going to pursue a career in science? Explain.
3- Why did you take an environmental science course?
4- Do you enjoy science courses? What has been your most favorite course? Least favorite?
5- Do you consider yourself to be a good science student? Why or why not?
6- Do you think you could become a better environmental science student? Explain.
7- Do you ever watch science documentaries outside of school? Why or why not? If yes can you provide an example.
8- Do you ever listen to or watch science news in the media? Why or why not? If yes can provide an example?
9- Do you ever read books or articles pertaining to science? Why or why not?
10- What topic do you enjoy learning about the most in environmental science?
11- What topic do you enjoy learning about the least in environmental science?
12- What do you think is your learning style (how do you learn the best; read, listen, collaboration…)?
13- Which methodologies from this course helped you learn concepts the best?
14- Do you think that the issues that you learn about in environmental science could play a role in your life? Can you provide an example?
15- Is there anything that surprised you from this course about the study of environmental science? Can you provide at least one example?
16- What do you think it means to be scientifically literate? Explain.
17- Do you think it is important to become scientifically literate? Why or why not?
18- Do you think you are scientifically literate? Why or why not?
19- What do you think is the most important environmental issue today?
20- Do you think that you can make an impact in overcoming environmental problems? Why or why not? Explain.
21- Is there anything else you would like to share about this environmental science course that we did not cover in the previous questions? Explain.

APPENDIX H

COLLEAGUE OBSERVATIONS

Colleague Observation Prompts

1- Engagement

2- Attitudes

3- Asking/Answering Questions

4- Interest in Subject matter

5- On Task

6- Other

APPENDIX I

STUDENT ACCOMMODATIONS AND RECCOMENDATIONS

Student Course Accommodations and Recommendations Survey

Directions:

This survey contains numerous prompts about this environmental science course. Based on your experience, reflect and respond to each prompt *honestly.* List any accommodations or recommendations that you think may be helpful in improving this course in the future. This survey will NOT affect your grade in this class in any way.

Text Material

Accommodations-

Recommendations-

PowerPoint Presentations

Accommodations-

Recommendations-

Text Chapter Work

Accommodations-

Recommendations-

Additional Text Worksheets

Accommodations-

Recommendations-

Documentaries

Accommodations-

Recommendations-