



***Your Brain on Exercise:
Linking Healthy Brains to Solutions for Environmental Health***

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This curriculum unit is recommended for:
AP Environmental Science 10-12 grade

Keywords: Environmental health and hazards, exercise, brain health, test scores

Teaching Standards: See [Appendix 1](#) for teaching standards addressed in this unit.

Synopsis:

Exercise and its potential impacts on the human brain is a topic that is increasingly in the news. This curriculum unit introduces high school students to the potential impacts that the simple act of exercising can have on the health of our brains. In addition, students are introduced to the challenges we face as a global society in trying to maintain our current lifestyle while maintaining the Earth in a condition where future generations can thrive. Brain health and its potential connections to human and environmental health are concepts that span the sciences. Clarifying this concept is one goal of the curriculum unit. A second goal is to provide the students with the basic necessary information to begin to understand how their lifestyle choices impact not only their own personal health, but the health and future sustainability of planet Earth. Students are introduced to these challenges and invited to research and demonstrate their own solutions. The exercises in this unit can be accomplished using the internet sources cited as well as common inexpensive materials. The unit has been designed to allow flexibility in modifying activities to meet the needs of Earth and Environmental Science as well as Biology courses at all high school levels.

I plan to teach this unit during the coming year to 110 students in AP Environmental Science grades 9-12.

I give permission for the Institute to publish my curriculum unit and synopsis in print and online. I understand that I will be credited as the author of my work.

Your Brain on Exercise: Linking Healthy Brains to Solutions for Environmental Health

Dr. Jeanne L. Cooper

Introduction

Teenagers today have been raised in a largely denatured world¹. They prefer to hang out within arms reach of electrical outlets over spending time outdoors actively using their bodies and brains. This fact has been in part responsible for the epidemic quantity of young people who now suffer from type II diabetes and obesity². Recent research also suggests that this sedentary lifestyle may be diminishing their brain power³. The goal of this unit is to help 9th-12th grade students in my AP Environmental Science and Honors Earth & Environmental Science classes discover that regular exercise may have benefits not only for their physical health, but also for their brains and possibly the overall environmental health of their communities. They will learn about cultural environmental health issues, their impact on overall environmental health, and recent research concerning the effects of exercise on the brain. In AP environmental science, we investigate environmental health including physical, chemical, biological, and cultural aspects. Cultural aspects of environmental health include lifestyle choices such as how much to exercise and what foods to eat. We learn that our lifestyle has much to do with the overall health of the environment from causing or preventing diseases such as type II diabetes to lessening our need and dependence on electronic technology. Recently, several doctors and medical practices have become popular because they promote prevention of disease through healthy lifestyle choices rather than our current approach to medical intervention that involves primarily reacting to diseases that already exist. We will investigate whether regular aerobic exercise could have an effect on people's overall health and whether aerobic exercise would have an effect on reducing incidences of disease including our ability to fight off infections and to remain free from depression. People who exercise generally have more energy and more interest in beneficial lifestyle practices. If more people exercised, could we reduce the amount of waste we produce? Could we reduce our dependence on mass produced food, which has a significant detrimental effect on the environment? If we as individuals were committed to a lifestyle that includes regular aerobic exercise, would we be able to increase our overall thinking ability? Could we reduce the number of individuals with chronic challenges such as ADHD and thus reduce our dependence on medications and the medical industry? The human species has increased its ability to survive on planet earth by increasing the carrying capacity of our global population primarily through brainpower and invention of new technologies. If more people exercised, would we reduce our impact on planet Earth as well as increase our brain's ability to invent new solutions?

An intertwined and related goal of this unit is to examine whether regular exercise improves the cognitive function and thus test scores for students. Teenagers of today will be responsible for finding solutions to complex environmental problems that impact our ability to survive and thrive on planet Earth for generations to come. It is important that they develop an understanding of these issues as well as their critical thinking and problem solving skills.

Setting

Mallard Creek High School is home to over 2500 students and is located in a part urban, part suburban setting in the University City area of Charlotte, North Carolina. Mallard Creek High School is one of over 30 high schools in the Charlotte-Mecklenburg School District and was recently recognized with the Silver Award for National Excellence in Urban Education. The student body is diverse and is comprised of 63% African American, 21% White, 6% Multi-Racial, 5% Asian, and 5% American Indians. Mallard Creek High School is incredibly fortunate to have a dedicated staff of teachers; over 50% have obtained a masters or doctoral degree and 15% have obtained National Board Certification. The school has consistently maintained a graduation rate of around 95% since its opening in 2007.

I currently teach Honors Earth and Environmental Science (HEES) as well as AP Environmental Science (APES) to students from diverse academic and socioeconomic backgrounds. My students are in the 9th-12th grades. MCHS operates on a 4 x 4 - 90 minute block schedule for all classes except AP level courses. The school schedule means that I teach a HEES class every day for a full semester and then teach it again to a new class of students for the second semester. AP courses meet every other day for the entire year. This school year I teach one section of HEES and four sections of APES.

The AP Environmental Science curriculum is provided by The College Board and is an interdisciplinary course that incorporates earth science, biology, and chemistry into understanding the interactions that occur in our environment. It is useful if the student has had two laboratory sciences (biology and chemistry are recommended) as well as at least Algebra I prior to entering APES. However, CMS only requires that students pass Algebra I prior to taking an AP science course. Therefore, the course I teach is academically diverse. The most important criteria for an APES student is to possess a strong work ethic and the ability to be a self-motivated learner. The curriculum for Honors Earth and Environmental Science is mandated by the North Carolina Department of Public Instruction (NCDPI). I follow the pacing guide provided by NCDPI as well as their general outline of units and standards to be addressed in each unit. The Honors Earth and Environmental Science course is a laboratory-based science class emphasizing the function of the earth's systems. Emphasis is placed on the human interactions with the earth's geologic and environmental systems, predictability of a dynamic earth, origin

and evolution of the earth system and universe, geochemical cycles, and energy in the earth system.

Background

Numerous studies have been published recently that describe a possible connection between exercise and brain health. Aerobic exercise appears to physically increase the size of the hippocampus and the amount of brain cell growth. Aerobic exercise also has been shown to improve mood, energy levels, and depression³. If more people committed to regular aerobic exercise, could overall environmental health improve? Would my student's ability to understand topics and concepts improve if they exercised more? What effects would we see if more movement was incorporated into the daily classroom routine?

Scientists have been linking physical exercise to brain health for many years and evidence shows that physical exercise helps build a brain that not only resists shrinkage, but increases cognitive abilities. We now know that exercise promotes a process known as neurogenesis or the brain's ability to adapt and grow new brain cells, regardless of your age³. Exercise has also been shown to increase creativity and help stimulate new solutions to problems. Researchers at Stanford University found that walking can increase creativity up to 60 percent⁴.

Exercise appears to help overcome depression by boosting natural "feel good" hormones and neurotransmitters associated with mood control, including endorphins, serotonin, dopamine, glutamate, and GABA³. Mice with well-trained muscles have higher levels of an enzyme that helps metabolize a stress chemical called kynurenine⁵. Mice with higher levels of PGC-1 α 1 in their muscles also had higher levels of enzymes called KAT. KATs convert kynurenine (a substance formed during stress) into kynurenic acid, which cannot pass from the blood to the brain. High levels of kynurenine can be measured in patients with mental illness. Research demonstrates that when normal mice were given kynurenine, they displayed depressive behavior, while mice with increased levels of PGC-1 α 1 in muscle were unaffected. These animals never show elevated kynurenine levels in their blood since the KAT enzymes in their well-trained muscles quickly convert it to kynurenic acid, which results in a protective mechanism⁵.

There is overwhelming evidence that exercise produces cognitive gains and helps fight dementia. In a study at Naperville Central High School, students who took part in a before school exercise program increased their reading and comprehension test scores by 17% compared to students who did not exercise and took part only in the cognitive literacy work³. A recent study at the University of Illinois demonstrated that aerobically fit nine and ten-year olds have more compact white matter in their brains⁵. Fast and efficient nerve activity has been linked to compact white matter. Those who exercise

have a greater volume of gray matter in the hippocampal region of their brains, which is important for memory³. Exercise also prevents age-related shrinkage of the brain, preserving both gray and white matter in the frontal, temporal, and parietal cortices, thereby preventing cognitive deterioration³.

One of the mechanisms by which the brain benefits from physical exercise is via a protein called brain derived neurotrophic factor (BDNF)³. BDNF is a remarkable rejuvenator in several respects. In the brain, BDNF not only preserves existing brain cells, it also activates stem cells to produce new neurons. New neurons are generated at an astounding rate compared to individuals who do not exercise³. In addition, regular exercise appears to reduce plaque formation by altering the way damaging proteins reside inside the brain³. Regular exercise also decreases the amount of bone-morphogenetic protein (BMP), which slows down the creation of new neurons³. In animal research, mice with access to running wheels reduced the BMP in their brains by half in just one week³. In addition, they also had a notable increase in another brain protein called Noggin, which acts as a BMP antagonist. This complex interplay between BMP and Noggin appears to be yet another powerful factor that helps ensure the proliferation and youthfulness of your neurons. BDNF also expresses itself in the neuromuscular system where it protects motor neurons from degradation³. A physical workout appears to help prevent, and even reverse, brain decay as well as preventing age-related muscle decay. Exercise is as good for the brain as it is for the rest of the body.

Several investigations have now been completed linking running to increased physical and mental health benefits. In a recent study, a team of researchers put four groups of mice into four different cages⁵. The first one, the "enrichment" cage, was a kind of mouse heaven offering trays of various cheeses, fruits, and nuts occasionally sprinkled with cinnamon, and an assortment of flavored waters to wash it all down. The main living area was a carnival fun house of neon-colored balls and tunnels, mirrors and seesaws, and small igloos for sleeping. Cage two had the identical enrichments of cage one with the addition of a running wheel. Cage three was empty, and the mice were fed plain kibble and water. Cage four was the same as cage three with the addition of a running wheel. So what did all these mice and all this enrichment disparity reveal? Essentially that the critical variable was whether or not the mice were running.⁵

Using an unusual approach, Mizuno Corporation contracted with the UNC Chapel Hill Kenan Flagler business school to study what overall affects would occur if everyone in the population was a runner⁷. Their results, published in 2014, include the following: \$130 billion in health care savings; \$47 billion added to the national GDP; nearly 2 billion pounds of total weight loss; 10 percent increase in household earning potential; 5 million fewer hospital visits; up to 46 percent fewer homeless; 20 million more great grandmothers; 7 billion more hours spent outside; 63 million happier dogs; and 135 million more victory beers⁷.

Rationale

The College Board AP Environmental Science standard VI.B requires that students evaluate impacts of environmental hazards on human health as well as the impacts of human lifestyle choices on environmental health. High school students are typically unaware of environmental hazards and even less aware of how their lifestyle choices can impact their health as well as the health of the environment. This part of the curriculum unit will allow students to explore the connections among environmental hazards, lifestyle choices, and overall environmental health. The topic of this curriculum unit has many links to biology as well as environmental science. Therefore, many of the activities outlined below could be adapted for an AP Biology or Honors Biology course.

Throughout the lessons, the concept of sustainability will be defined and discussed. Sustainability is typically defined as meeting our current needs as a global society without hampering the ability of future generations to meet their needs. College Board standard VII requires analysis of changes to Earth's systems and their effect on species diversity and the health of ecosystems as well as maintenance strategies such as conservation. Students need to understand that personal lifestyle choices can and do impact overall global environmental health and can provide the ability to leave planet Earth habitable for future generations⁸.

Part I – Environmental Health

We will define cultural environmental health as a basis for investigating the impact of exercise on the brain. Cultural environmental hazards include some factors within our control and some that are not in our control. For example, choosing to smoke can cause health problems and is a personal choice within each individual's control. Being exposed to second hand smoke may not be within an individual's control. Exercise is a choice each person can make to benefit their overall health, including their brain. In addition, several doctors have recently called the medical establishment into question for their approach to treatment of health problems⁹. The current medical approach is reactionary; treat the symptoms with drugs and expensive tests. Many doctors are switching their paradigm to one of a proactive nature. For example, preventing many diseases such as Alzheimer's by adopting healthy lifestyles that include exercise and better food choices. Our current approach to medical intervention involves environmental damage from the production of medications and machinery as well as increased energy usage due to maintaining state-of-the-art technology and facilities. In this part of the curriculum unit, students will examine research on the connections between lifestyle choices and health.

Part II – Exercise and Brain Health Investigations

In any AP science course, some of the main objectives include learning how to set-up and conduct a scientific investigation as well as how to interpret and communicate the

findings. In order to investigate the connections among brain health, exercise, and cultural environmental hazards, the students will choose a specific focus to investigate. Students will choose a topic and design their own experiment which will be conducted over the duration of the second semester of the year-long course. The main objective is to encourage students to exercise and monitor how exercising impacts their own lives.

Activities

The activities we will accomplish have been set up around the questions and topics that need to be covered during this unit. I have purposely left some activities in a general state so that they can be used in either my HEES course, APES course, or as part of a Biology course. For the APES classes, students will be able to delve deeper into some topics and spend more time on certain activities than my HEES students. I have assigned a timeline to the activities based on a second semester project in my APES class. The schedule would need to be modified if this project is done in my HEES class or in a Biology course.

What is Cultural Environmental Health?

Hazards that result from our place of residence, our socioeconomic status, our occupation, or our behavioral choices can be thought of as cultural or lifestyle hazards. Choosing to smoke, poor diet, and living in proximity to toxic waste are all cultural hazards. Many environmental health hazards exist indoors. Cigarette smoke and radon are leading indoor hazards and are the top two causes of lung cancer in developed nations. Disease is also a major focus of environmental health. Many major killers, such as cancer, heart disease, and respiratory disorders, have genetic bases but are also influenced by environmental factors. Malnutrition can foster a wide variety of illnesses, as can poverty, poor hygiene, lifestyle choices, and lack of exercise. Over half the world's deaths result from non-infectious diseases, such as cancer and heart disease, while one death in 11 is due to injuries. Many diseases are spreading because we are so mobile in our modern era of globalization. The changes we cause to our environment can also cause diseases to spread. Students will participate in an exercise using Glo Germ to simulate the ease with which bacteria and diseases can spread¹⁰. They will then examine statistics on lifestyle choices and how these impact individual and overall environmental health.

What is Sustainability and Why Should We Care About Our Ecological Footprint?

Sustainability is a far reaching concept in both the AP Environmental Science and Earth & Environmental Science curricula. In this unit, we learn about sustainability from the

standpoint of making lifestyle choices that increase our personal health, our brain's ability to think through complex problems, and our ability to use these advantages to prevent damaging planet Earth beyond repair. The students will explore these concepts by utilizing an online tool to calculate their ecological footprint¹¹. They will then continue using computers to play the Duke Energy Game. Duke Energy Corporation offers a free online game where players attempt to provide enough energy for the global population in 2050 while reducing Duke Energy's carbon footprint. Although this unit is not focused on energy resource issues, the Duke Energy game illustrates how difficult it is to meet the demands of society while still protecting the viability of planet Earth¹². Prior to leaving class, we will engage in a discussion of the two activities and highlight the challenges with reducing ecological footprints at an individual and corporate level. Students will submit their own definition of sustainability as well as their completed ecological footprint.

What is the Impact of Exercise on the Brain?

There are numerous links among brain health and exercise. Students will begin by reviewing a few summary articles that explain the relationships among brain health and exercise. They will then choose an area to explore further during their second semester project. We will view the video "What if Everyone Ran?" and look at a chart developed by Mizuno detailing the results of this study⁷. Mizuno posed this question to the UNC Kenan-Flagler School of Business. Four MBA students, UNC's chief marketing officer, and a team from McKinney (a leading advertising agency) worked to analyze data to determine what impact running would have on society as a whole and on individuals. The findings demonstrated the profound impact a single lifestyle change could potentially have on our society if enough people adopted this change. In this case, the change involved a regular routine of running. However, any regular exercise routine that affects the human body in similar ways could potentially have the same outcomes. It is clear from Mizuno's study and from other research discussed previously in this curriculum unit that exercise has a profound impact on the brain and potentially on our overall health as a society.

Semester Long Project

The goal of this project is to encourage students to adopt exercise as part of their lifestyle. For students who already participate in a regular exercise routine, the project requires them to make connections among their physical health and brain function. For students who do not currently exercise, it encourages them to begin exercising either as part of the project or to do research on the impacts of exercise on specific brain functions. A desirable outcome is for students to learn how important exercise is to their health and overall environmental health and to make changes in their own lifestyles. Students will determine how to incorporate more exercise into their lives and monitor how that activity increases their ability to score well on tests or other brain benefits such as increased

memory and overall mood. Students who choose to investigate the effects of exercise on cognitive ability will work individually to report percentage increase or decrease in test scores in order to meet privacy requirements. For example, some students may choose to investigate whether regular exercise increases brain health based on results of academic work such as formal assessments. Because it is not possible to force students to add exercise to their personal lives, others topic choices will be available that primarily require research. For example, students may choose to investigate whether increased intelligence due to exercise could allow us to solve certain environmental problems and increase the carrying capacity of the human species. Other students may choose to document improved brain function due to exercise and make correlations to decreased risk of brain diseases such as Alzheimer’s. The choice of topics and timeline of due dates is provided in Figure 1. A rubric for evaluating the project is provided in Figure 2. If funding is approved, each student will have a Fitbit or other personal fitness tracker¹³. If funding is not approved for Fitbits, students will use inexpensive pedometers provided by University Run for Your Life to track daily steps.

Figure 1. Project choices and timeline

Project Focus Exercise effects on...	Required Tasks	Timeline and due dates	Final product due date
<ul style="list-style-type: none"> • Cognitive ability • Alzheimer’s disease • Parkinson’s disease • Depression • ADHD/ADD • Carrying capacity of the human species 	<ul style="list-style-type: none"> • Written report • In class presentation • Power point or Prezi • Bilbiography 	<ul style="list-style-type: none"> • Project introduced: January 26th • Topic and group membership choice: February 1st • Progress check 1: February 26th • Progress check 2: March 23rd • Progress check 3: April 22nd • Progress check 4: May 13th 	<ul style="list-style-type: none"> • May 23rd • In class presentations: May 24th-26th and May 31st - June 2nd
<p>This project is intended to consist of primarily data collection and research prior to May 2nd. It is expected that you incorporate concepts learned as appropriate and as we cover them in class. The bulk of the analysis, synthesis, and compilation of your work will be done after the AP exam on May 2nd when we will have few additional classroom assignments.</p>			

Figure 2. Rubric for Evaluation of Research Project

1 Did not meet expectations	2 Often met expectations	3 Always met expectations	4 Exceeded expectations			
Presentation						
Were you ready to present on time?			1	2	3	4
Evidence of organization and planning (Is the info presented in a logical order, does the presentation run smoothly, did you practice several times?)			1	2	3	4
Substantive and relevant content (Did you stick to the point, did you use and explain technical terms?)			1	2	3	4
Effective communication of ideas (Did you prepare what you were going to say? No reading from slides! Were you confident? Did you avoid “filler” words like <i>so</i> , <i>OK</i> , <i>um</i> , and <i>like</i> ? Did you pronounce words correctly?)			1	2	3	4
Understanding and appropriate application of concepts and theories. (Are you able to answer questions from your audience?)			1	2	3	4
Presentation Grade						
Visual Project						
Did you turn your product in on time?			1	2	3	4
Evidence of planning; Does the presentation run smoothly?			1	2	3	4
Understanding and application of concepts and theories (Does your presentation support what you are trying to convey?)			1	2	3	4
Effective use of materials and visual appeal			1	2	3	4
Organization and Purpose: Title describes project in ten words or less. Statement thoroughly explains problem presented.			1	2	3	4
Visual Project Grade						
Written Project						
Introduction: Shows proper explanation of concepts. Includes facts from previous research.			1	2	3	4
Materials and Procedure: Provided list with all used materials. Stated quantities needed. Include even if all you did was research.			1	2	3	4
Data: Includes data table & graphs that are properly labeled. Written observations are provided. Both qualitative and quantitative data included. Choose at least one data set and create your own graph. Cite graphs and tables that you include from other researchers.			1	2	3	4
Conclusions and Evaluation: At least 3 paragraphs. Introduction includes, what was investigated. Middle Paragraph(s) includes a						

discussion of the major finding of the experiment and/or research, supported with data. Comparison among other research. Last paragraph provides possible explanations for findings, includes recommendations for further study and further applications.	1	2	3	4
Written Project Grade				

Conclusion

As teachers, we are tasked with preparing students for jobs that do not exist yet, that will use technologies that have not been invented, to solve problems we do not know are problems yet. High school students of today have grown up in a world of instant gratification and instant access to enormous amounts of information. I feel strongly that teenagers need to learn how to think critically and problem solve so they are ready to face the challenges of the future. They need to learn how to sift through the exponential amount of information retrieved with just one Google search. Students need to be able to evaluate information in order to be informed citizens and help solve the challenges that are facing our society. In addition, high school students should be exposed to as many real world problems as possible in order to make their learning relevant and fun. Investigating the links among brain health, exercise, and environmental health and hazards is an engaging/appropriate topic with which to challenge student's thinking as well as expose them to real world questions and challenges that they as adults will need to solve or at least understand in order to be responsible citizens.

Notes

- (1) Richard Louv, *Last Child in the Woods* (Chapel Hill, North Carolina: Algonquin Books of Chapel Hill, 2005), 10
- (2) "Childhood Obesity Facts," August 2015, <http://www.cdc.gov/healthyschools/obesity/facts.htm>
- (3) John J. Ratey, MD, *Spark: The Revolutionary New Science of Exercise and the Brain* (New York, New York: Little, Brown and Company),
- (4) "Stanford study finds walking improves creativity," April 24, 2014, <http://news.stanford.edu/news/2014/april/walking-vs-sitting-042414.html>
- (5) Karolinska Institutet. "How Physical Exercise Protects the Brain from Stress-induced Depression." *ScienceDaily*. ScienceDaily, 25 Sept. 2014. Web. 31 Oct. 2015.
- (6) "How Running Keeps your Brain Humming," October 22, 2014, <http://www.runnersworld.com/newbie-chronicles/how-running-keeps-your-brain-humming>
- (7) "What if Everyone Ran?," March 2014, <http://www.kenan-flagler.unc.edu/news/2014/03/Mizuno-run-project>
- (8) Wackernagel, Mathis, and William E. Rees. *Our Ecological Footprint: Reducing Human Impact on the Earth*. Gabriola Island, BC: New Society, 1996
- (9) "The Paleo Cardiologist The Natural Way to Heart Health," 2015, <http://thedrswolfson.com>
- (10) "Glo Germ Archives - Educational Innovations Blog." *Educational Innovations Blog*. Educational Innovations, Inc., 1 Jan. 2015. Web. 31 Oct. 2015.
- (11) "Ecological Footprint," *Global Footprint Network*, 2014, <http://www.footprintnetwork.org/en/index.php/GFN/page/calculators/>
- (12) "Energy Challenge," *Duke Energy Corporation*, 2014, <http://energychallenge.duke-energy.com/>
- (13) "There's a Fitbit Product for Everyone." *Fitbit Official Site for Activity Trackers & More*. N.p., n.d. Web. 31 Oct. 2015.

Resources

List of Materials for Classroom Use

- Computers, iPads, or access to a computer lab
- Internet access
- Classroom projector
- Copies of pertinent articles
- Fitbits or other step tracking and heart rate monitoring devices

Reading List for Students

Bryson, Bill. *A Walk in the Woods: Rediscovering America on the Appalachian Trail*. New York: Broadway, 1998. Print. An entertaining and educational account of the 2100 mile Appalachian Trail delivered by Mr. Bryson after he walked these miles. He provides a detailed history of the trail and notes current destruction of the forest and ecosystems. Warning of future destruction and the perils associated with this are also included.

Carson, Rachel, Lois Darling, and Louis Darling. *Silent Spring*. Boston: Houghton Mifflin, 1962. Print. Rachel Carson's classic and passionate look at the destruction of our air, land, and water. First published in 1962, it led to radical changes in environmental laws and regulations

Gore, Al. *An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do about It*. New York: Rodale, 2006. Print. A look at the destruction we are causing on planet Earth due to global warming and a warning about what consequences lay ahead if we do not change our actions now. Written by former Vice President Al Gore, the book was a *New York Times* #1 bestseller and began the conversation about climate change.

Hiaasen, Carl. *Hoot*. New York: Alfred A. Knopf, 2002. Print. A fictional story about a middle school boy's quest to save owls from the construction of a pancake restaurant in Florida.

Krakauer, Jon. *Into the Wild*. New York: Anchor, 1997. Print. The account of the last months of John McCandless's life as he travels on a spirit quest into the wilderness after rejecting his wealthy lifestyle and upbringing.

Leonard, Annie, and Ariane Conrad. *The Story of Stuff: How Our Obsession with Stuff Is Trashing the Planet, Our Communities, and Our Health--and a Vision for Change*. New York: Free, 2010. Print. An exploration of the dangers of our over consumptive lifestyle and its impact on our health, economy, and environment.

- Miller, Arthur I. *Insights of Genius: Imagery and Creativity in Science and Art*. Cambridge, Mass: MIT, 2000. Print. Explores how scientists and artists use creative leaps to answer new questions and further the pursuit of knowledge.
- Nash, Roderick. *Wilderness and the American Mind*. New Haven: Yale UP, 1967. Print. An account of American's changing attitudes toward wilderness over history and the birth of the conservation and environmental movements.
- Reisner, Marc. *Cadillac Desert: The American West and Its Disappearing Water*. New York, NY, U.S.A.: Viking, 1986. Print. A thoroughly researched history of water resources in the American West and a lesson on the politics and economics of limited resources anywhere.
- Seuss. *The Lorax*. New York: Random House, 1971. Print. Dr. Seuss's classic and whimsical look at the dire consequences of environmental destruction.
- Wackernagel, Mathis, and William E. Rees. *Our Ecological Footprint: Reducing Human Impact on the Earth*. Gabriola Island, BC: New Society, 1996. Print. A look at how quickly we are using up resources on planet Earth, especially in developed countries, and how we cannot sustain this lifestyle. An ecological footprint calculator is included with detailed explanations of how we can make positive changes.

Bibliography for Teachers

- Gillan, Becky. "AARP Blog." *AARP*. 20 Apr. 2015. Web. 24 Sept. 2015. <<http://blog.aarp.org/2015/04/20/can-a-healthy-body-equal-a-healthy-brain/>>. Describes how exercise can improve or prevent diseases that typically strike older adults such as Alzheimer's.
- Kolbert, Elizabeth. *The Sixth Extinction: An Unnatural History*. New York: Henry Holt, 2014. Print. A detailed account of how humans are causing the fifth mass extinction event on planet Earth.
- Lawrence, Michael. "MIZUNO | What If Everyone Ran?" *Vimeo*. Mizuno, 7 July 2014. Web. 24 Sept. 2015. <<https://vimeo.com/100164280>>. A video summary of the study conducted by UNC Kenan-Flager business school that analyzed data to determine how our society could change if everyone ran.
- Leonard, Annie, and Ariane Conrad. *The Story of Stuff: The Impact of Overconsumption on the Planet, Our Communities, and Our Health--and How We Can Make It Better*. New York: Free, 2011. Print. An exploration of the dangers of our over consumptive lifestyle and its impact on our health, economy, and environment.

- Macrae, Fiona. "A Couch Potato Lifestyle Doesn't Just Make You Fat - It Also Shrinks Your BRAIN." *Mail Online*. Associated Newspapers, 05 Mar. 2015. Web. 24 Sept. 2015. <<http://www.dailymail.co.uk/health/article-2979425/A-couch-potato-lifestyle-doesn-t-just-make-fat-shrinks-BRAIN.html>>. A description of how a lack of exercise affects your brain on many levels.
- "One Simple Way to Improve Your Brain Function." *Psychology Today*. 20 Sept. 2015. Web. 24 Sept. 2015. <<https://www.psychologytoday.com/blog/the-athletes-way/201509/one-simple-way-improve-your-brain-function>>. A connection among exercise and how your brain works with a specific emphasis on the advantages to exercising in improving psychological problems such as depression.
- Parent, Marc. "How Running Keeps Your Brain Humming." *Runner's World & Running Times*. Runner's World, 02 Oct. 2014. Web. 22 May 2015. <<http://www.runnersworld.com/sports-psychology/how-running-keeps-your-brain-humming>>. A specific look at how running can help your brain remain health including cognitive function and memory.
- Reynolds, Gretchen. "The Right Dose of Exercise for a Longer Life." *Well The Right Dose of Exercise for a Longer Life Comments*. New York Times, 15 Apr. 2015. Web. 24 Sept. 2015. <<http://well.blogs.nytimes.com/2015/04/15/the-right-dose-of-exercise-for-a-longer-life/>>. A summary of how much exercise appears to be enough to improve brain function based on current research.
- Rothman, Hal. *Saving the Planet: The American Response to the Environment in the Twentieth Century*. Chicago: Ivan R. Dee, 2000. Print. A detailed account of the efforts during the twentieth century to improve and solve environmental issues.
- UNC Kenan-Flagler Business School. *What If Everybody Ran?* University of North Carolina Chapel Hill, 7 Mar. 2013. Web. 24 Sept. 2015. <<http://www.kenan-flagler.unc.edu/news/2014/03/Mizuno-run-project>>. An exploration of the dangers of our over consumptive lifestyle and its impact on our health, economy, and environment.
- Wackernagel, Mathis, and William E. Rees. *Our Ecological Footprint: Reducing Human Impact on the Earth*. Gabriola Island, BC: New Society, 1996. Print. A thorough description of the myriad ways an ecological footprint can be calculated. Explores the pros and cons of various approaches.
- Wolfson, Jack. *The Paleo Cardiologist The Natural Way to Heart Health*. Morgan James Pub, 2015. Print. A summary of one doctor's quest to change the paradigm of the medical community from reactive care to proactive care.

Appendix 1: Implementing District Standards

This unit will implement the College Board standards for AP Environmental Science. These standards require the students to understand cultural environmental hazards and the affect a healthy lifestyle has potentially on human's ability to make healthy choices for themselves and for the environment. Students will critique the benefits, costs, and environmental impact of various lifestyles. They will also analyze how changes in lifestyle could impact our economy.

VI. Pollution

B. Impacts on the Environment and Human Health

1. Hazards to human health (Environmental risk analysis; acute and chronic effects; dose-response relationships; air pollutants; smoking and other risks)

2. Hazardous chemicals in the environment (Types of hazardous waste; treatment/disposal of hazardous waste; cleanup of contaminated sites; biomagnification; relevant laws)

C. Economic Impacts (Cost-benefit analysis; externalities; marginal costs; sustainability)