



Curriculum Units by Fellows of the National Initiative
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Energy, Environment and Health Electromagnetic Fields: Are They Buzzing You?

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The Unit

I have chosen to focus on the possible health effects of Electromagnetic Fields, also known as EMFs, within our everyday environment. I will research mainly the possible health effects of electromagnetic fields on humans and how we may be able to lessen our exposure to EMFs by changing our habits or using other forms of energy.

By using a cross curricular approach to writing my unit, I can incorporate Language Arts, Social Studies, Math and Science objectives in to my lessons. This unit will be inquiry based. Students will use critical thinking skills, the writing process, and will be able to draw conclusions based on observations while working in collaborative groups.

This unit is designed for a sixth and seventh grade Gifted and Talented class. This class has approximately thirty students and meets three times a week for one eighteen week semester. The unit will be broken into three parts and take approximately six weeks to complete. Students should have a basic knowledge of energy and the human body. I will collaborate with the science teacher to make sure that students have already begun their studies of the human body. This unit will be introduced in class, and students will be given several class periods for collaborative work; however students will need to complete independent work at home.

Why I chose this topic

I have a large power tower that holds six electrical lines in my yard. It is thirty three feet from the west side of my home. My children climb and play under the tower almost daily. I often get questions about the tower. "How safe is it?" "Does it buzz all the time?" "Will your children get sick?" are some of the questions that are typically asked. I must admit that when I first bought the house, I asked the same questions to my realtor. I was assured that it was safe. The Department of Veteran Affairs came out to observe the tower before they would approve our VA loan. Again, I was told it was safe; I found out later that the VA office did not check for

electrical fields, only for ground wires and if the house was in the "fall zone" of the tower. My youngest son has had health issues since birth (however they are minor compared to diseases such as cancer). I have always wondered if the electromagnetic fields from the tower could be a factor in my son's health ailments.

My situation made me think about some of our schools being located near power lines, as well as, students' homes. Should we be concerned about the possible health effects from these lines? We go about our everyday lives and sometimes do not stop to look at what is near us, why it is there and what it could do to us. Power lines are not the only source of EMFs. Everyday appliances and wiring in homes also emit electromagnetic waves. Since humans are spending the majority of their day inside near electrical appliances and gadgets, I thought it would be interesting to look at how these fields may affect our health. We use electrical devices all the time, but do we really know all there is to know about them?

Why I think it is Important

I have taught energy sources as an overview for the last nine years in my seventh grade geography class. Students usually roll their eyes at alternative sources such as solar power or wind turbines because they are accustomed to electricity. Students typically do not relate to the information presented over types of energy; the only exception that I can recall is the year we had an ice storm/ blizzard and missed fourteen days of school. Most students were without power for ten or more days. When the students came back to school they discussed how hard life was without electricity. Most complained that they were unable to use their computers, the batteries in their cell phones and iPods died, they had to cook their food in the fireplace if they had one or eat sandwiches, and they had to use candles to see at night. Most students came back to school saying they wished they had solar panels or other forms of energy to use. That class had a wonderful discussion about energy sources that year. I would like all classes I teach to have a meaningful lesson over energy sources that will have them thinking and learning how energy impacts their lives and the world around them.

Students today live in a very fast paced technology driven world. Yet, they have only a small idea of how things work, where they came from, or how they could possibly affect their health. Students seems to only be interested in the instant gratification of an item and do not think about the source of an item or long term affects this item could have on them. By researching EMFs, I hope to help students gain knowledge about the electronically driven world around them and how these electronics could impact their health.

The Unit

Students will expand their vocabulary, write journals and observation logs, conduct research, draw charts, graphs and maps to illustrate data collected, and produce and energy savings plan as their final assessment. This unit will be broken into three phases. First, students will research and discover what EMFs are, how they are formed, and what effects they could have on people and environments. In the second phase students will discuss possible places EMFs can be found and how they are measured. In an observation log students will keep track of how much time they spend inside and what electrical devices are around them. By mapping

their most used area, students will be able to label the locations of the electrical devices they are around most often; students will then research to determine the level of EMFs around them in their normal routines. Phase three of the unit will be the final assessment for the students. Students will complete a final project by presenting an energy saving plan that will help reduce the exposure to EMFs in their daily lives. My goal is for students to leave the unit understanding what EMFs are, how electronic devices impact their everyday lives and future, and to have a sense of ownership in lessening their energy consumption while improving their lives.

Background Information

Electricity and Power Lines

Electricity is the most common form of energy used in the United States and several countries around the world. How is the power from the energy plants transmitted to where we need it? Power lines are used to move the electrical currents from the original source to homes and businesses across populated areas. Most power lines are suspended in the air running from power tower to power tower; some lines are placed underground. The amount of power that a line transmits is simply the product of its voltage and current ¹ . Power systems are designed so that line voltage is held relatively constant over time while currents are permitted to rise and fall with power demand ² . These lines emit an electrical magnetic force, also known as EMFs. These lines are necessary to run currents of electricity to residential and business populations.

Public concern regarding towers first began in the 1960's, with most of the focus on the aesthetic impact of the large towers, on the esthetic and ecological impacts of rights of way and on various nuisance effects created by their strong electric fields. The public also complained about noise levels. In 1989, approximately 350,000 miles of transmission line and about 2 million miles of distribution line crossed the United States to supply electricity to the ever growing population. ³ The AEP (American Electric Power Company) services eleven states in the Mid-West and reports to have 39,000 miles of transmission lines and 223,000 miles of distribution lines that deliver electricity to 5.3 million customers. ⁴ The building of towers and distribution lines will continue to increase as long as the population continues to be dependent on electricity.

What are EMFs and where can they be found?

Electromagnetic fields are found almost anywhere. They occur naturally in nature and are also found in and near devices that are powered by energy. Wherever electricity is generated, transmitted, distributed, or used, electric and magnetic fields are created, often at significant intensities, due to the presence and motion of electric charges. ⁵ These fields are not only found near electrical lines, they are emitted from household appliances, cell phones and any other electrical device. Thunderstorms produce electrical fields, as well as, the Earth's core.

Electric fields occur when voltage moves across a line. Electric fields are measured in Volts. These fields are always present, even when a device is turned off. You can decrease your exposure to electric fields by creating distance between yourself and the source. Also, most building materials will shield you from electric fields. Magnetic fields occur when currents flow through wires. These fields exist as soon as a device is switched on or a current flows. Field strength decreases with distance; however, most building materials do

not shield you from magnetic fields. Together these fields are known as electromagnetic fields. EMFs are relied on to help run microwaves, televisions and radios. EMFs are also responsible for holding atoms together in chemical compounds. ⁶ People are unable to sense these fields (with an exception of a rare few that claim to be allergic) and EMFs are not visible by the human eye, even though they are present everywhere.

Measuring EMFs

EMFs produce signals in the form of waves. These waves are known as a sine wave. ⁷ Sine waves create measurable fields; EMFs are measured in units called milliGauss (mG). Measured units drop off significantly with distance: so the further away from an EMF the lower the exposure. Background EMF levels in homes range from 0.5 to 3mG with higher reading in front of major appliances (washer, dryer, refrigerator, television). There is no set public health safety standard for EMF levels. Most reports suggest keeping exposure rates fewer than 10mG and staying 300 feet away from power lines. ⁸

A report by the U.S. Congress, Office of Technology Assessment, has provided EMF measurements of common electrical devices found in our everyday lives. Below are the mean (average) measurements of some devices while in use.

Table 1
Typical Household Appliances Magnetic Field Measurements

Appliance	Magnetic Field at 6"	Magnetic Field at 1'
Can Opener	600mG	150mG
Vacuum Cleaner	300mG	60mG
Hair dryer	300mG	1mG
Microwave	200mG	40mG
Electric Shaver	100mG	20mG
Mixer	100mG	10mG
Copy Machine	90mG	20mG
Garbage Disposal	80mG	10mG
Blender	70mG	10mG
Fluorescent Light	40mG	6mG
Battery Chargers	30mG	3mG
Electric Range	30mg	8mG
Washing Machine	20mG	7mG
Analog Clock	15mG	2mG

Information in this graph was provided by the Office of Radiation and Indoor Air, Radiation Studies Division, US Environmental Protection Agency

Possible health risks associated with EMFs

Scientist began looking at EMFs and the possible effect on human health in the 1970's. The studies came about because several electrical workers in the Soviet Union began reporting illness that could be related to the transmission towers and the EMFs that were released in the immediate area. The reports were easily dismissed by Western medicine; however the public latched on to the theory.

Ever since the Soviets complained of the EMFs possibly causing negative health issues, studies have been

conducted in the United States and other parts of the world. These studies have had different results. Some studies have found related links to EMFs and health issue. Several studies suggest that health risks related to EMF depend on many variables including duration of field exposure, strength of the field, the person's mass and age, general health, and probably genetic predisposition or vulnerability to cancer. ⁹

Cancer

In 1979, a study was released that looked as the possibility of EMFs from power lines having a direct correlation to childhood cancer (leukemia). This study was conducted by Wertheimer and Leeper in Denver on children that had lived in homes near high current distribution lines as compared to those living further away from the lines. The study looked at 344 cases and 344 controls and concluded that those living near the distribution lines with higher exposure to EMFs had a 1.6 to 2.2 fold higher incidence of cancer than controls. ¹⁰ The findings of this study were disputed because they only looked at cases of death from cancer instead of all cases of cancer in the area.

Many other studies have since tried to link EMFs with health problems. A study conducted in Sweden and reported by Tomenius in 1986 found that there were more electrical constructions near the homes of cases of children with cancer than with the control group. Another study, conducted in Denver by Savitz, was very similar to the study conducted in 1979 by Wertheimer and Leeper. However, Savitz paid attention to more factors that were identified as weak in the first study. Savitz results showed that a child in a high exposure area was much more likely to have cancer than the control groups located in lower exposure areas. ¹¹

While the above mentioned studies found a possible correlation between EMFs and childhood cancer, many other studies have had contradictory results. In 1989 the U.S. Congress released material to calm the populations' fears as to health concerns of EMFs. The report summarized Wertheimer and Leeper's study, as well as, Savitz' study. The report also included more research that found inconclusive evidence of the relationship on EMFs and health concerns. Two other studies that were included in the Congress material from 1989 have found no relationship between exposure to EMFs and cancer (particularly leukemia).

The studies were conducted in Rhode Island and Yorkshire, England. The Rhode Island Study included 119 childhood leukemia incidence cases and 240 controls, and was similar to the Wertheimer and Leeper study. The study in Yorkshire looked at all children diagnosed with cancer during 1970-1979, a total of 376 cases and 591 controls. Residence classification was first made in terms of proximity to overhead power lines. Among those of the homes within 100m of the power lines, EMFs were estimated. There was no relationship observed between cancer incidence and either exposure. ¹²

Cell functions in humans and animals have been disturbed from EMF exposure. Effects have been reported as the result of EMF exposure including changes in cell membrane function, metabolism, cellular signal communication, cell stress and possible cell death. ¹³ Some scientists believe that cell disruption caused by exposure to EMFs could lead to the decrease in melatonin production of the body. Various cancers might result if melatonin is lowered in the body. Decreased melatonin levels have been implicated in breast cancer, prostate cancer, and ovarian malignancies. ¹⁴

Even though several studies have been done, there are still mixed results as to the possibility that EMFs may contribute to cancer. The U.S. Congress report went on to say that the studies by Wertheimer and Leeper and Savitz do show some evidence that EMF exposure could cause cancer, overall evidence is too weak to allow

firm conclusions on the correlation of EMFs as a cancer promoter. ¹⁵

Hypersensitivity

More and more studies are being done on EMFs because people are now claiming to have sensitivity to electrical fields (electrical and magnetic fields were previously described as undetectable to humans at one time) as more and more advanced technology is developed. Symptoms that people have reported are a warm or burning feeling, a tingling sensation across the face or other body parts, extreme dryness of mucus membranes and swelling of nose, throat, ears or sinuses without any infectious cause. Problems with concentration, loss of memory and dizziness have also been reported, as well as, headaches and nausea. ¹⁶ It has been suggested that people feeling the above symptoms should look at their environments and note if any new electrical devices have been introduced, including, but not limited to, Wi-Fi technology, cell phones, computers or television sets. Research has suggested to remove oneself completely from the modern world (go camping) for a short time; if all of the ailments go away, then one could be sensitive to EMFs. Of course this is widely debated since research has shown that stress could have the same effects on health as the ones mentioned above.

Other Health Impairments

Other studies have suggested that exposure to EMFs for long durations could cause behavioral changes, aggravation, aggression, and miscarriages. Research has shown that exposures to EMF are linked to heart-rate variability, blood pressure problems, acute myocardial infarction, and abnormal patterns that can be detected with an electrocardiograph. ¹⁷ In a study by Dr. De-Kum Li, the risks of possible miscarriages were higher in people routinely exposed to EMFs. ¹⁸ The miscarriage risks were correlated to the use of electric blankets, however, there is still much debate concerning the findings. EMFs can also affect sleep patterns. A study by Dr. R. Huber exposed male volunteers to the radiation from a mobile phone for thirty minutes before they went to sleep. This exposure resulted in changes in the electrical signals of the brain and reduced the amount of sleep and sleep efficiency. ¹⁹ There is also evidence that EMFs have contributed to symptoms of headache, fatigue, fuzzy-headedness, memory problems and depression. ²⁰

There are numerous studies that shown a relationship to EMF and health impairments, while just as many other studies would deny the relationship. Studies have shown that EMFs tend to pose more health problems for occupational workers, pregnant woman and young children. Future tests and studies will continue to arise on this subject matter. The World Health Organization has started to collect and look at data of EMFs. I think this is a topic that will continue to be researched for a long time, especially as society becomes more and more dependent on technology.

Positive Applications of EMFs

Not all hope is lost; EMFs have also been looked at to help treat patients with certain ailments. Electro chemotherapy has been used in cancer patients where efficient cancer therapy has been hard to find. The thought is that the electric fields help break down or kill cells (as stated above as negative effects) exposing cancer agents and speed immune system response. ²¹ EMFs have also been used to help repair bone fractures that have stopped healing and has also been used in clinics for therapeutic

purposes. ²² One study completed on mice concluded that EMF exposure could be an effective, non-invasive and drug-free way to prevent and treat Alzheimer's disease in humans. The research suggested that the

increase in brain temperature helped the Alzheimer's brain to remove newly-formed beta-amyloid plaque (a peptide of 36-43 amino acids) and boosted memory. ²³ As with all studies, these are widely disputed, stating that there is not enough evidence to prove that the electromagnetic field is the lone cause for the results. Too many other factors could have contributed to the results.

I will say that it was difficult for me to find examples of positive information related to EMFs. Most studies conducted were looking at possible harmful effects of EMFs or disproving harmful results of EMFs by stating that there was not an association between EMFs and health impairments. The three positive examples that I came across were buried in negative or inconclusive studies regarding EMFs.

Legal Actions

In November 1985 a case was brought before the courts in Harris County, Houston, Texas. The Houston Lighting and Power Company sued the Klein Independent School District of Houston over a 345,000 volt transmission line that crossed school property.

The problem had begun in 1981, when the company instituted condemnation proceedings for eight and a half acres of the school district's land, and built a power line that ran within 300 feet of an elementary school, 130 feet from an intermediate school, and less than 250 feet from a high school. From the outset, Donald Collins, the superintendent of the district, had raised questions about the possible health effects of the power line, and when he received no satisfactory answers to his queries the school board had refused to grant Houston Lighting and Power a right of way, and the company sued. ²⁴

Several specialists and scientists that have studied EMFs, including Nancy Wertheimer, were called to testify in this case. The jury found in favor of the Klein Independent School District stating that the Houston Lighting and Power Company had "abused its discretion" by not informing the school of possible health risks and that this constituted a "willful and unreasoning action", so the company was ordered to pay the school district \$104, 275 as compensation for actual damages. The company was also required to pay a restoration fee for restoring the school property to its original condition of \$42,113,120, as well as \$25 million dollars in punitive damages. ²⁵ This judgment was appealed and found its way through the court system ending at the Texas Supreme Court in 1986. The Court upheld the original judgment and ordered the power line down. In 1987, the Appeals Court reversed the \$25 million punitive damage award because the power company had been in technical compliance with the Texas Property Code but upheld the rest of the verdict ruling that the jury had been correct in finding "clear and convincing evidence" of potential health hazards caused by electromagnetic fields. ²⁶ The power line was removed from the school's property and more lawsuits were brought against the power company; one from a family whose land had been condemned by Houston Lighting. The lawsuits alleged that the EMF from the lines was responsible for brain tumor that a family member developed in 1987. Later the lawsuits that were brought against the power company were dropped.

In 1996 a policeman in Virginia filed a suit with the Virginia Workers' Compensation Commission stating that his testicular cancer was caused by his hand-held radar gun. ²⁷ The policeman had his doctors testify that leaving his radar gun in his lap was a direct result of his testicular cancer. Even the doctor that testified for the city had stated that his exposure was "bothersome". The commission ruled that the policeman had proved "to a reasonable degree of medical certainty" that his disease was caused by exposure to radar. However, his claim was denied because he had filed too late. The city decided to compensate him by paying for his medical expenses that were not covered by insurance and restore his sick leave instead of fighting the appeals

process.

Several lawsuits have been brought up against power companies and manufactures of appliances and technological devices, especially cell phone manufactures as of recent. It seems most lawsuits tend to not get through the legal process mostly because of cost reason. Several cases in recent years have sided with large companies due to lack of evidence that EMFs are the main cause to the particular health impairment. ²⁸

Ways to help reduce exposure to EMFs

Electromagnetic fields are everywhere, so how does one go about protecting themselves from possible overexposure? While the controversy continues over the possible health of effects of EMFs, there are simple steps one can take to reduce their exposure. The first and most obvious way to reduce exposure would be to distance yourself from the source. The further away the lower the field level. Other suggests are as follows:

- Use battery operated equipment- they use less of a current
- Unplug any electrical devices not in use
- Do not place your bed near a wall where cables, water pipes, dimmer switches, or ceiling fan controls are located
- Try not to place your bed near a wall that has a large electrical device on the other side: refrigerator, television, computers, electrical boxes
- Use cell phones only as needed (try to use a land line for long durations) and try not to carry phones on your body
- Do not rest your laptop on your legs
- Keep a distance of at least three feet from computer screens and hard drives
- Use electric dryers as little as possible, do not over dry clothes
- Do not use an electric blanket all night. Use it to warm the bed before getting in, then turn it off and unplug it.
- Nightlights should not be located next to the bed
- Do not sit too close to a television. Six feet or more is suggested as a safe distance. Be sure to read the owner information manual for exact recommendations from the manufacture
- Do not stand next to a microwave oven that is in use
- Use a regular toothbrush instead of an electric one
- Buy low emission appliances
- Keep copy machines away from work areas
- Before purchasing a new home have EMFs measured
- Install a demand switch which cuts power of to a circuit when a circuit is not being used
- Do not build within 300 feet of power lines or transformer stations
- Try to become less dependent on the national power grid and look for alternatives such as solar power

Conclusion

I found there is not an exact answer to the question "Are EMFs a danger to your health?" However, I personally believe after reading several studies and books that there is a high probability that EMFs affect humans in a negative way. Are EMFs they dangerous? I believe so after this research. Are they more dangerous than riding

a motor cycle without a helmet? That is arguable, but I believe that most people know the possible dangers of not wearing a helmet. Average citizens and especially children do not know the possible risks of EMFs (or what EMFs are in some cases), so they cannot protect themselves from the unknown.

Another conclusion I have come to from working on this topic is that there will always be contradictory answers on this topic. I have learned that depending on how research is completed the results can trend towards a favored outcome or can be picked apart by the opposing side as to the quality or methods used to determine the results. I will use the philosophy of "it is not the end conclusion but the process of getting there" for the research results that my class comes to when researching this topic.

I began this research not only because I could include it in my teaching, but also because I have a personal reason for looking at the effects of Electromagnetic Fields. I did come in to this research with a bias view because of a power tower being in my yard, and my youngest son having health issues. I was looking to find a correlation from the very beginning. I still cannot say if the EMFs are the exact reason that my son has experienced health problems since birth, but I also cannot say that they are not a factor. I currently have a scheduled appointment for the electrical company to come to my home to measure the electromagnetic fields near the tower and inside my home. I am considering the possibility of moving if the readings come back higher than normal. As soon as I have the reading I will update this section of the unit.

Activities

Before beginning this unit, students will have examined *Walden* by Henry David Thoreau. Students will have discussed the simplicity of life and the core values of the book. The class will then compare Thoreau's *Walden* to our current ways of living.

This unit is broken into three parts and will take approximately two weeks for each section. I have each class for 90 minutes two days a week and 45 minutes on Friday.

Part One

1. Compare and contrast today's way of living with Thoreau's idea of living simply.

What is different? What is the same? Why

What is the difference between a want and a need?

Have we polluted our living environments with our "wants"?

2. I will put a picture of my children playing in the yard under or on the power tower.

Students will journal their observations, thoughts, and questions about the picture.

Students will share their writing in groups and agree on one question to ask as a group. Discussions will continue from the questions asked. (I am hoping that one of the questions asked is "Is that safe", if not, I will pose that question myself.)

3. Discuss the use of electricity and how it is moved from its source to our homes or schools.

I will present a short summary of electricity, currents, voltage and how it is moved. Then I will bring up the fact that the transmission lines release Electromagnetic Fields.

4. Vocabulary terms will be given to help the students better understand terms that will be found during their research: Current, voltage, watts, electric fields, magnetic fields, transmission, milliGauss

5. Students will be assigned to research electromagnetic fields and write a report

regarding what are EMFs, where are EMFs found, how EMFs are measured, and any possible effects EMFs may have on humans.

Part Two

1. Students will turn in and discuss their finding on EMFs. The class will discuss the possible impact of EMFs in their everyday lives.

2. Students will be assigned to keep a journal the next three days (hopefully a Thurs, Friday and Saturday)

Students will log where they are and how much time they spend in that area every day for three days

3. After three days, students will make a chart showing how much time they spend in different areas. (It would be interesting to graph the amount of time inside vs. Outside)

4. After determining where students spend the most time, they will draw a map to scale of that particular room. (More than likely their bedroom)

Students will then locate any electrical device, including light switches and plug in, and place their location on their map

5. I will bring an EMF gauge to class (hope to borrow one from the local university) to measure the EMF fields around the classroom. We will then go outside and look at readings in the open green space behind our school. While in the green space I will place the gauge next to me and tell the students the reading. Then I will have the students walk to me one at a time with their cell phone and/or iPod in their hand until the entire class is around the gauge. The class will observe how the reading changes as more and more electrical devices come near the gauge.

6. Students will be given a chart with average EMF reading of typical household devices. (See Table 1) Using their map, students will make an estimate to the EMFs in their most used area.

Part Three

1. After making average EMF levels for the most used area in a student's life, students will hold a discussion of how this could impact their health.

2. Students will create a plan to reduce the energy used in their most used area with the hope to reduce their exposure to EMFs.

3. Students will then return to their groups and design an energy savings plan for the school.

4. For the two weeks of part three, I will challenge the students to go back to the simple life, referring to Thoreau, by not using one electrical device for two weeks. Students will choose the device (I believe none will choose their cell phone, and will remind them that computers are needed at school for projects sometimes).

Students will keep a journal during this time to record their thought about this challenge.

5. Students will present their energy savings plan to the school administration and teachers.

6. Students will also write a summary of how their life was affected during the two weeks of not using their electrical device they agreed to give up to live life simply.

Possible Extension Activities:

1. Look at alternative energy sources used in Oklahoma. Research the source and make an advertisement to promote the use of the alternative energy source.

2. Collect information as to types of energy used around the world and determine why areas rely on certain energy sources.

3. Build working models of windmills and solar panels.

Appendix 1: Core Curriculum Standards Sixth Grade

Reading Informational Text:

6.RIT.1 Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

6.Rit.4 Determine the meaning of words and phrases as they are used in a text, including figurative and connotative meanings; analyze the impact of a specific word choice on meaning and tone.

6.RIT.7 Integrate information presented in different media or formats (e.g. visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

6.RIT.9 Compare and contrast one author's presentation of events with that of another.

Writing:

6.W.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts and information through the selection organization , and analysis of relevant content

6.W.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose and audience.

6.W.7 Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.

6.W.8 Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or

paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.

Speaking and Listening:

6.SL.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher- led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.

6.SL.4 Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.

6.SL.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.

Ratios and Proportional Relationships:

6.RP.3d Use ratio reasoning to convert measurement units: manipulate and transform units appropriately when multiplying or dividing quantities.

Statistics and Probability:

6.SP.1 Recognize a statistical question as one that anticipates variability in the data related to the questions and accounts for it in the answers.

6.SP.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

6.SP.5 Summarize numerical data sets in relation to their context, such as by:

- a. reporting the number of observations.
- b. describing the nature of the attribute under investigation, including how it was measure and its units of measurement.
- c. giving quantitative measure of center (median and/or mean) and variability as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.

Geometry:

6.G.1 Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply these techniques in the context of solving real-world and mathematical problems.

Appendix 2: Table 1

Typical Household Appliances Magnetic Field Measurements

Appliance	Magnetic Field at 6"	Magnetic Field at 1'
Can Opener	600mG	150mG
Vacuum Cleaner	300mG	60mG
Hair dryer	300mG	1mG
Microwave	200mG	40mG
Electric Shaver	100mG	20mG
Mixer	100mG	10mG
Copy Machine	90mG	20mG
Garbage Disposal	80mG	10mG
Blender	70mG	10mG
Fluorescent Light	40mG	6mG
Battery Chargers	30mG	3mG
Electric Range	30mg	8mG
Washing Machine	20mG	7mG
Analog Clock	15mG	2mG

Information in this graph was provided by the Office of Radiation and Indoor Air, Radiation Studies Division, US Environmental Protection Agency

Works Cited

1. U.S. Congress, Office of Technology Assessment, Biological Effects of Power Frequency Electric & magnetic Fields- Background Paper, OTA-BP-E53 (Washington, DC: U.S. Government Printing Office, May 1989): 1
2. U.S. Congress 1989 (2)
3. U.S. Congress 1989 (2)
4. American Electric Power "About Us" <http://www.aep.com/about> (accessed July 17, 2012)
5. Habash, Riadh W. Y.. *Bioeffects and therapeutic applications of electromagnetic energy*. Boca Raton: CRC Press, 2008: 14
6. U.S. Congress 1989 (2)
7. McLean, Lyn. *Watt's the buzz?: understanding and avoiding the risks of electromagnetic radiation*. Melbourne, Australia: Scribe Publications, 2002.: 17
8. Ginsberg, Gary, and Brian Toal. "Power lines and EMFs." In *What's toxic, what's not*. Berkley trade paperback ed. New York: Berkley Books, 2006. 295-304
9. Ginsberg Gary, and Brian Toal, 2006 (297)
10. U.S. Congress 1989 (58)

11. U.S. Congress 1989 (58)
12. U.S. Congress 1989 (58)
13. Habash, Riadh W.Y., 2008 (41)
14. Habash, Riadh W.Y., 2008 (45)
15. U.S. Congress 1989 (65)
16. Manne, Rycharde. "What Are The Symptoms Of Electromagnetic Hypersensitivity?" Science 20
http://www.science20.com/florilegium/what_are_symptoms_electromagnetic_hypersensitivity (accessed July 15, 2012).
17. McLean, Lyn, 2002 (72)
18. " Microwave News "Maximum EMF Exposure Emerges
As Strong Miscarriage Risk:". <http://microwavenews.com> (accessed July 15, 2012). May/June 2001
19. McLean, Ly 2002 (80)
20. McLean, Lyn 2002 (61)
21. Gehl, Julie, "Electrochemotherapy as Part of an Immunotherapy Strategy in the Treatment of Cancer," *Advanced Electroporation Techniques in Biology and Medicine* .Jun 2010 , 425 -429
22. Habash, Riadh W.Y., 2008 (105)
23. Arendash, Gary W, "Electromagnetic Field Treatment Protects Against and Reverses Cognitive Impairment in Alzheimer's Disease Mice," *Journal of Alzheimer's Disease*, Volume 19:1 (January 2010): Accessed July 11, 2012,
<http://www.jalz.com/press/2010/20100106.html>.
24. Brodeur, Paul. *Currents of death: power lines, computer terminals, and the attempt to cover up their threat to your health*. New York: Simon and Schuster, 1989.(193)
25. Brodeur, Paul, 1989 (198)
26. Brodeur, Paul, 1989 (198)
27. Microwave News, "Police Radar, Officer Wins Settlement" March/April 1996
28. Brodeur, Paul, 1989 (217)

Annotated Bibliography

American Electric Power "About Us" <http://www.aep.com/about> (accessed July 17, 2012)

Arendash, Gary W, "Electromagnetic Field Treatment Protects Against and Reverses Cognitive Impairment in Alzheimer's Disease Mice," *Journal of Alzheimer's Disease*, Volume 19:1 (January 2010): Accessed July 11, 2012, <http://www.jalz.com/press/2010/20100106.html>.

Brodeur, Paul. *Currents of death: power lines, computer terminals, and the attempt to cover up their threat to your health*. New York: Simon and Schuster, 1989.

This book reviews several well-known studies. The book also provides information regarding legal cases involving power companies and electromagnetic radiation.

Electric and magnetic fields: hearing before the Subcommittee on Energy and Power of the Committee on Energy and Commerce, House of Representatives, One Hundred Third Congress, first session, April 1, 1993.. Washington: U.S. G.P.O. :, 1993.

Gehl, Julie, "Electrochemotherapy as Part of an Immunotherapy Strategy in the Treatment of Cancer," *Advanced Electroporation Techniques in Biology and Medicine* .Jun 2010 , 425 -429

Ginsberg, Gary, and Brian Toal. "Power lines and EMFs." In *What's toxic, what's not*. Berkley trade paperback ed. New York: Berkley Books, 2006. 295-304.

Interesting: The book also provides information about other forms of pollution in our lives.

Gittleman, Ann Louise. *Zapped: why your cell phone shouldn't be your alarm clock and 1,268 ways to outsmart the hazards of electronic pollution*. New York: HarperOne, 2010.

This book was very helpful with the entire research process. Its' main focus was on electrical devices in our everyday world.

Habash, Riadh W. Y.. *Bioeffects and therapeutic applications of electromagnetic energy*. Boca Raton: CRC Press, 2008.

Very technical. Was helpful in finding positive uses of EMFs.

Manne, Rycharde. "What Are The Symptoms Of Electromagnetic Hypersensitivity?." *Science 2.0* http://www.science20.com/florilegium/what_are_symptoms_electromagnetic_hypersensitivity (accessed July 15, 2012).

McLean, Lyn. *Watt's the buzz?: understanding and avoiding the risks of electromagnetic radiation*. Melbourne, Australia: Scribe Publications, 2002.

The entire book is helpful when researching electromagnetic fields. Gave several examples of how to reduce EMFs in public areas.

"Microwave News | News & Comment." *Microwave News | News & Comment*. <http://microwavenews.com> (accessed July 15, 2012).

Several resources and references are found on this site.

Nair, Indira, M. Granger Morgan, and H. Keith Florig. *Biological effects of power frequency electric and magnetic fields*. Washington, DC: Congress of the U.S., Office of Technology Assessment :, 1989.

Great source. Helpful in individual readings of electromagnetic fields from household appliances. Also compared several studies over EMFs.

Portier, Christopher. *Assessment of health effects from exposure to power-line frequency electric and magnetic fields: NIEHS Working Group report*. Research Triangle Park, NC (P.O. Box 12233, Research Triangle Park 27709): National Institute of Environmental Health Sciences, U.S. National Institute of Health, U.S. Department of Health and Human Services, Public Health Services, 1998.

Helpful with exposure measurements.

Sugarman, Ellen. *Warning: the electricity around you may be hazardous to your health : how to protect yourself from electromagnetic fields*. New 2nd ed. Miami Beach, Fla.: Miriam Press, 1998.

Surrounded by Waves. Laser Disc. Directed by Jean-Christophe Ribot. New York: ArteFrance ; Mosaïque Films , 2009.

Very interesting, could be used in the classroom with middle school or high school students

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