

Wi-Fi radiation levels at BCIT: An analysis of three buildings at the Burnaby campus

Ketan Minhas¹, Bobby Sidhu²

¹ Lead Author, B. Tech Student, School of Health Sciences, British Columbia Institute of Technology, 3700 Willingdon Ave. Burnaby, BC V5G 3H2

² Supervisor, School of Health Sciences, British Columbia Institute of Technology, 3700 Willingdon Ave. Burnaby, BC V5G 3H2

Abstract

Objective: To determine if there are any difference in the amount of EMF Wi-Fi radiation being emitted between three locations at the BCIT campus in Burnaby, BC.

Background: Wi-Fi radiation is widely being used in today's society for the quick access it gives us to connect to the internet. Some cities in the United Kingdom have installed many Wi-Fi devices throughout the public domain so people can be connected all the time. Furthermore, most schools are being outfitted with routers to provide internet access for their students. But, as this paper will show, new research is forcing a shift in the thinking of some policy makers in choosing to install these connections in the public domain.

Method: To measure the amount of non-ionizing EMF radiation being absorbed by the body, an Extech RF meter was used. This instrument provides instantaneous and average readings for a particular area one measures.

During the experiment, the RF meter was held stationary at one location for approximately 10-15 seconds in order to stabilize the reading. The average value was taken as the instantaneous reading was fluctuating. This process was done in 3 buildings at BCIT and in order to increase the reliability and validity, 30 data points were collected from each building.

Results: The Tests of Assumption showed that the data was not normally distributed as there was more than one "Reject" at the 0.05 probability level. For analysis, the Kruskal-Wallis One-Way ANOVA was utilized and results showed that due to a high probability level of 0.57, the H₀ could not be rejected and as a result there are no differences in radiation levels being emitted into the buildings tested.

Conclusion: The amount of Wi-Fi radiation in the three buildings tested at BCIT were not significantly different from one another.

Keywords: Wi-Fi, EMF, radiation, BCIT, schools, public, building, internet

Introduction

The notion that electromagnetic (EM) radiation is not a public health issue has been under attack with new evidence emerging worldwide. This type of radiation is non-ionizing and thus does not contain enough energy to release electrons from their orbits. The danger is that electrons cause free radicals to form which could cause mutations in DNA and eventually lead to cancer (Paehlke, 1995). The WHO explains that only ionizing radiation is capable of causing damage to biological systems and non-ionizing radiation sources like WIFI routers are harmless to humans (WHO, 2013). As a result, we see them being used more and more throughout our homes, cities, and schools.

Non-ionizing radiation is emitted by a variety of different products found in our homes and in public environments. Baby monitors emit low levels of radiation for wireless connections and routers allow us to access the internet from any location in the house (Environmental Protection Agency, 2014). Furthermore, some cities in the U.K have been adding Wi-Fi devices throughout their region to make the internet accessible from anywhere in the city. Canadian universities, colleges, high schools, and even elementary schools have installed these devices to give students the ability access the web at any time (Alberta Health, 2012).

Since this technology is fairly new, there is very little known about its long terms impacts. Children are spending, on average, eight hours a day inside buildings which are constantly being covered by Wi-Fi signals. These signals bounce around from room to room at the speed of light and end up covering most areas of the school. So far, the WHO claims that there are only thermal effects caused by radio waves (WHO, 2014). Governments and organizations who are in support of Wi-Fi claim that there are no other serious health risks involved with this technology.

But, before there is any further spread of this emerging technology, should we not ask what its long term impact will be on our bodies? Even though it makes our life easier, should we be ignoring the results of studies conducted in Norway which showed detrimental effects to plants from Wi-Fi radiation?

Even though countries like the U.K., Canada, and U.S. openly use this technology, European countries like Switzerland are showing signs that they rather take a precautionary step before installing Wi-Fi sources ubiquitously in our environment. Public health agencies in Austria have suggested that schools should be using hard wired internet connections rather than wireless to protect children (Austria Public Health Department, 2005). In cases of young populations, some schools have been stripped of all

Wi-Fi devices and have become Wi-Fi free zones. These governments claim that it is too early to tell if there are any long term effects of this radiation. As a result, prominent scientists are beginning to change their views until further research on the impact of Wi-Fi radiation can be fully studied.

Our study will aim measure radio frequency levels at BCIT and determine if there are any differences in exposure levels to humans within various buildings at BCIT, Burnaby.

Literature Review

1.2 - Wi-Fi Technology

This technology allows devices like laptops and cellphones to connect with the internet wirelessly anywhere where there is a signal that your device can pick up. This signal is usually transmitted by a router, or base station, at a particular radio frequency band which another device recognizes.

These radio signals, also known as electromagnetic radiation, are what allow communication between your device and the internet. When we try to connect to the internet via our laptop, we must first connect to the base station or router; once connected, the router will compact and code the information from the particular website we are surfing and transmit that data via electromagnetic radiation (Wifi Alliance, 2013). In the end, both the device and router will send information wirelessly as radio waves and the router station will act as a communicator between the internet and your device.

1.3 - What are radio signals?

Signals transmitted by routers and devices are in the form of an electromagnetic radiation called radio waves. The electromagnetic spectrum is made up of various frequencies and wavelengths and part of which, includes radio signals. In this part of the spectrum, signals are transmitted at the speed of light and have frequency ranges of 10 – 300 Hz. This frequency range and those around it are known to be non-ionizing radiation. The most common types of radiofrequencies used are in the 2.4 GHz and 5 GHz band ranges (Wifi Alliance, 2013).

1.4 - What is non-ionizing radiation?

Non-ionizing radiation sources are considered low energy and do not possess enough energy to remove electrons, protons, or neutrons from their chemical bonds (WHO, 2013). Only ionizing radiation has the ability to do that and the removal of electrons is known to have devastating effects on humans (EPA, 2013). So far, the only known short-term effects of non-ionizing radiation, or low energy radiation, like microwaves (MW), radio waves (RF), U.V, and electricity are thermal effects (EPA, 2013).

Even then, Health Canada has developed Wi-Fi radiation exposure level guidelines, Safety Code 6, for controlled and

uncontrolled environments (Health Canada, 2009). Under the recommended levels, the Health department claims there is no considerable public health risks associated with radiofrequency energy exposures (Health Canada, 2009).

Table 1 - Exposure Limits for Controlled Environments

Frequency (MHz)	Electric Field Strength (V/m)	Average Time (min)
1 500 – 15 000	137	6

Table 2 – Exposure limits for Uncontrolled Environments

Frequency (MHz)	Electric Field Strength (V/m)	Average Time (min)
1 500 – 15 000	61.4	6

1.5 - What is ionizing radiation?

As we move along the electromagnetic spectrum, the frequency increases and so do the dangers for humans. Ionizing radiation consists of alpha and beta particles, gamma radiation, or neutrons (Health Canada, 2008). These particles have enough energy to break bonds and release atoms from their orbits. These free particles can eventually cause DNA damage which may lead to mutations and cancer. Naturally, Canadians are receiving on average 2.7 millisieverts of ionizing radiation yearly from naturally occurring sources like radon (1.0 mSv), cosmic rays (0.3 mSv), X-rays (0.6), and other sources (0.8 mSv) (Health Canada, 2008). The millisievert is used internationally to measure the amount of radiation dose that a person will receive (Health Canada, 2013). This radiation can be inhaled, ingested, injected, or absorbed which leads to the body, or part of it, being irradiated (EPA, 2007).

1.6 - Effects of non-ionizing radiation on plants

A very simple experiment conducted in Norway by ninth grade students, which tested the effects of radiation on watercress grass seeds that were planted in one room without any radiation sources nearby versus another room where seeds were placed near a Wi-Fi router. showed that without any radiation sources nearby, seeds sprouted and grew but the seeds near the router did not (Savedge, 2013)..

1.7 - Past research findings

In North America, there are no known bans on the use of Wi-Fi in schools. Furthermore, it has become such a popular technology that it has even made it inside the body of many heart patients receiving pacemakers. In 2009, Carol Kasyjanski became the first American recipient of a wireless pacemaker approved by the FDA (Gruber, 2009). The device communicates with doctors' at least once a day letting them know the exact status of their patient and the pacemaker. With the device being so close to organs in the body, it seems plausible that it may be having some negative effects on the bodies tissues.

One of the worldwide leaders of medical research in radiation and health is the Karolinska Institute in Norway.

Professor Olle Johansson (Ph.D) is the lead researcher in the department of neuroscience and has published many papers concerned with the effects of radiation on human health. Johansson’s research has lead him to believe that EMF sources are affecting people beyond just the thermal effects suggested by some organizations. In fact, some of his findings show that radiation has been demonstrated to manifest as sleep disorders and depression in humans (Manzetti & Johansson, 2011). EMF exposure is associated, not correlated, with cognitive disorders because of its effect on neurohormonal responses in the brain which eventually lead to depressed mental states, reduced appetite and disturbances of cholesterol levels (Manzetti & Johansson, 2011). As a result of his study, the researcher concluded that there should be some protection from radiation for sensitive populations within areas like schools, hospitals, residential areas, public transport and similar locations. Also, there have been a number of reported cases occurring worldwide where governments and the courts have accepted people as being hypersensitive to EMF radiation even though there has not been any reliable or proven evidence of this condition. Even then, as we see in Table 5, countries have taken precautionary measures in regards to EMF sources in order to protect their citizens (WifiinschoolsAustralia, 2013).

Table 3 – Examples of Countries Reducing Exposure of Wifi Radiation for their Citizens

Country/City	Action Taken
Switzerland	- The local governments in Switzerland are opting for limiting the use or all out removal of wifi devices in their cities. They suggest that the devices be strategically placed in schools to reduce exposure for kids and to use wired connections over wireless devices being installed, especially in classrooms where kids would be exposed continuously .
France – St. Clair	Municipality removed all wifi sources from schools and public buildings and converted to hard wired connections instead
Israel	- As of 27 August 2013, guidelines will stop the installation of wifi before the first grade and limit their use between grades 1-3.
Austria – Salsburg	- The public health Department of Salzburg has recommended to schools to not use wifi. The document, written to the principal and parents, advised that from the empirical evidence so far observed had showed symptoms like headaches, concentration difficulty, restlessness, and memory problems (Austria Public Health Department, 2005)

Furthermore, a peer reviewed study published in Fertility Weekly tested what the effects of Wi-Fi sources, like laptops, would be on human sperm. They had hypothesised, that male fertility would actually be reduced as a result of Wi-Fi radiation. The experiment showed that sperm motility was reduced in the experimental group that had a laptop near the petri dish and a higher proportion of DNA fragmentation versus without any electronic devices near the sperm (Avendano, 2012). This study goes against what has been presented so far, even by the Canadian government, that non-ionizing radiation sources only produce a thermal effect.

Even the American Academy of Environmental Science wrote a letter on May 13, 2013 to Superintendents of the School Districts of the United States to voice their concern over Wi-Fi . They wrote that since “the WHO elevated their exposure to wireless radiation into the class 2B list of carcinogens”, and “the Journal of American Society for Reproductive Medicine- Fertility and Sterility found that hours after exposure of to a standard laptop using Wi-Fi , caused DNA damage to sperm”, and “the American Academy of Pediatrics wrote a letter to Congress requesting an update to the safety levels for microwave radiation exposure especially for children due to their developing brains and thinner skulls”, it is better to exercise caution and substitute a safe alternative such as a wired connection, which is not classified as a possible carcinogen (American Academy of Environmental Science, 2013). This new line of evidence and concern is beginning to show that, at current levels, the amount of non-ionizing radiation may have some harmful effects (non-thermal) to humans. There should be greater scrutiny when we begin to install these devices near sensitive populations like children in elementary schools.

Methods and Materials

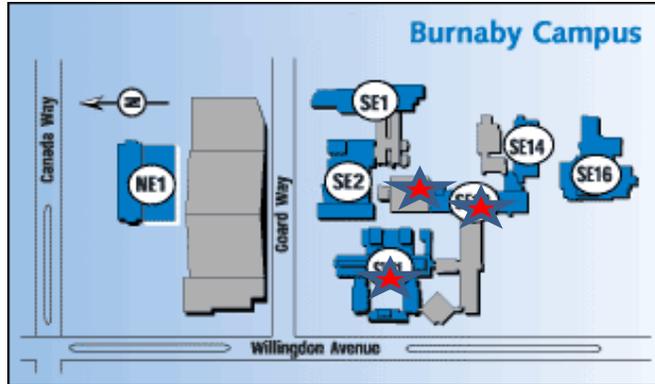
The research was conducted in buildings SW1, SE6, and the Great Hall located at the BCIT Burnaby campus. For each location, 30 points were randomly chosen and an EMF radiation reading was taken.

Extech has recommended that the instrument be held steady during the measurements so we have chosen 30 seconds as a time limit so the readings can stabilize in each direction The V/m unit was chosen as the default unit to measure electric field strength.

The Maximum average (MAX AVG) was chosen because it shows the highest average value measured. From the pilot study, it was discovered that the device showed fluctuating readings which never truly stabilize in the “Instantaneous” mode. As recommended by Extech Instruments, when the instantaneous measurements values are fluctuating greatly, the “Average” or “Max Avg” modes are to be used. Since either mode can be chosen, the “Max Average” mode was chosen to highlight how high the radiation can be inside of a classroom. For the purpose of this study, the “Max Avg”

mode will be chosen to highlight the potential amount of radiation which can be absorbed by humans.

Figure 1. Map of BCIT Burnaby and location of the three measurement sites



★ Star denotes location of experiment (SW1, SE6, Great Hall)

Reliability and Validity of Measures

Equipment: Validity was heightened through the use of a reliable and proven data recorder like the RF EMF Strength Meter (Model 480846) from Extech Instruments. It is able to measure frequencies of 900MHz, 1800MHz, 2.7GHz, 3.5GHz , 8GHz.

Calibration: The RF EMF Strength meter needs to be calibrated according to the frequency being measured. The Calibration factor (CAL) provides a means to improve the accuracy of the results display by calibrating against the output of a known frequency generator. Since Wi-Fi technology is emitted in the 2.4GHz band, we will be using a calibration factor of 1.0 (Extech, 2012). Refer to the procedure section to learn how to calibrate instrument.

Inclusion & Exclusion: The experiment will be conducted at the Burnaby BCIT campus. The readings will be taken in the middle of each class and in the hallways of the sites. Due to time constraints, only three buildings on the campus will be chosen and approximately 20 classrooms and 10 hallway locations (equally spread out) in each building will be measured.

The experiment will only be conducted when there are no other interferences from cellphones or laptops in test areas. To ensure this, readings will be taken after a majority of the classes have finished for the day, or after 3pm.

Pilot Study

A pilot study was conducted on November 8, 2013 at the BCIT Burnaby Campus. For the purpose of this experiment, test sites SW1 and SE6 were chosen as comparison groups. Approximately 15 data points were collected from each building consisting of mostly classrooms, lab rooms,

computer labs, and sometimes hallways. A hallway was chosen simply because not all of the classrooms were accessible. So, in order to increase the validity of the test, we supplemented the data by recording in a hallway. The other remaining 15 data points are hypothetical and were created randomly considering the values already recorded. The third building’s data set will be randomly generated for the purpose of the statistical test. The whole building was measured by dividing the reading into 10 points on each floor. Most of the readings were done in the middle of a room and were taken for 2 minutes (refer to procedure section).

Some of the data points showed spiked results due to some interference from cell phones or other electronic devices and this was considered for the actual experiment. Furthermore, it is unknown whether any laptops or computers in computer labs were interfering with the measurements.

Results

An analysis of all 3 groups was conducted using NCSS and Excel software using all 30 points for each group. The following tables summarize the results obtained:

Table 4 – Summary of descriptive statistics report

	Count	Mean	Std. Deviation	Std. Error	Min	Max	Range
SW1	30	298	309	56	4	1633	1629
SE6	30	229	137	25	6	666	660
Great Hall	30	240	136	25	8	401	393

The descriptive results show that building SW1 has the highest value (1633mv/m) along with the widest range. Also, it can be noted that SW1 has the lowest value recorded during the experiment. On the other hand, the Great Hall had the lowest max average value reading at 401mv/m.

The mean, or average value, for all of the buildings were relatively close to each other with values ranging from 229-298mv/m.

Inferential Statistics

To test our groups, we performed a Analysis of Variance ANOVA test on NCSS and the results of the analysis are as follows (Bobby Sidhu, personal communication, November 13, 2013):

- (i) **Tests of Assumptions** – The tests of assumption analysis had 3 rejects out of 4 and this indicates that our groups are not normally distributed. Because of this, we can read the results of the Kruskal Wallis test for our probability results.

- (ii) **Kruskal-Wallis** – When our p-value is set at 0.05, our analysis shows a probability level of 0.57.
- (iii) **Tukey-Kramer** – This test showed that there is no one particular group that is different from one another.

Discussion

Our probability levels showed that we cannot reject the null hypothesis and there are no differences in radiation levels between buildings at BCIT. In other words, as students travel from building to building, they are experiencing the same amount of Wi-Fi radiation and this interpretation was based on the analysis of variance tests performed in the NCSS software. Unless students are working far enough from the building, where there would be zero radiation levels, they are constantly exposed to this EMF force throughout their day.

On the other hand, when students are travelling within the same building, they may be experiencing different levels of radiation room to room. These levels can be as low as 5mV/m or as high as 1100 mV/m. But, as we compare all the data points within each building, they are comparable to each other.

Even though we know there are some levels of non-ionizing radiation in the buildings, they never exceed the 6 minute average of 61.6 V/m as set by Health Canada. The highest value recorded, 1.633 V/m, was recorded in SW1 and it far exceeds other values in the same building by more than 50%. Most values in these building range approximately from 100 mV/m to 500 mV/m. According to Health Canada, these levels represent a safe zone where there the public is not at any risk for harm or disease.

However, we do not know what the effects of these low levels of radiation will be to patients of pacemaker technologies. We know that putting your laptop on your lap slows down sperm motility in men so one could only imagine what the effect will be if Wi-Fi is transmitting right against the heart.

Even for non-sensitive populations, there have been studies which have shown some association associations with Wi-Fi and disrupted mental states (Manzetti & Johansson, 2011). However, whether the levels found in this study could produce these symptoms are not conclusive. Only background levels of Wi-Fi radiation levels were measured without actually measuring the effects of current levels.

However, there has been a shift in perceptions of Wi-Fi radiation and North America has been slowly catching up to the standards of some European nations regarding its health effects. As of March 27, 2013, the FCC (United States Federal Communication Commission) has decided to “advance its review of its various rules pertaining to radiofrequency (RF) emissions from radio emitters” (FCC, 2013). However, we do not really know which evidence they will be looking at and how long this study is really going to

take. So far, Health Canada maintains its current position that Wi-Fi radiation under its suggested levels does not pose any significant acute or chronic health effects (Health Canada, 2009).

This new concern with Wi-Fi levels in the public realm could not be soon enough as new products emerge daily which use Wi-Fi. Along with phones, new products like tablet PC’s, Smart TV’s, laptops, routers, and other portable devices which use Wi-Fi technology are only adding to background radiation levels. This was especially apparent while researching as there would be a dramatic jumps (atleast 1 V/m) when a cell phone was nearby. If we take into account the laptops, cell-phones, and other devices students are using during the day, it may begin to approach threshold levels. Also, it is unknown whether new technologies like signal boosters will increase the levels of radiation in the environment.

Limitations

First of all, the amount of radiation being detected by the monitor fluctuated drastically depending on the direction it was pointed. Thus, if the measurement for each location in a building is only taken for 4 directions (4 different angles on a circle) without recording all other directions (remaining 356 degrees), then we may have missed a true representation of the radiation levels.

Also, based on a lower power level, 79%, a larger sample size is needed. But, due to financial and time constraints, a larger study was not feasible.

Recommendations

Wi-Fi is a relatively new technology and we need to be careful before we spread its use any further all over our environment. This is especially true of children who are, in most cases, more susceptible to hazards (biological, chemical, radiation, etc.) in the environment. We need more time and research into non-ionizing radiation and determine what its long term effects are before we begin exposing everyone.

The best approach so far seems to be a precautionary one where we should limit our exposure to Wi-Fi radiation until we found out its long term effects. Rather than exclusively say that wireless devices only cause thermal effects, governments should be warning their citizen to be cautious before they use this technology extensively. We need to find out what the long-term effects are exactly? What should be limits be for Wi-Fi technology near schools? How should we teach the public on how to use the technology safely?

Future Research

Researchers need to conduct further research into the impacts of this particular wavelength of radiation and its impact on

the human body. This can only be done if governments begin to fund future research concerning chronic health effects from Wi-Fi radiation and especially focus on the health risks for children. Due to the low power of the study, a larger study with a bigger sample size should be conducted in the future. Furthermore, future researchers may want to conduct prospective cohort studies to look at the impacts of Wi-Fi radiation sources on humans. Also, there needs to be research conducted on how far Wi-Fi radiation travels outside of a building in case we need to have Wi-Fi free buildings.

Conclusion

Our study has shown that there were no differences in non-ionizing radiation levels between the chosen buildings at BCIT. The probability level far exceeded our set value of 0.05, and thus we can accurately suggest that as students travel between buildings, they are experiencing the same level of exposure to Wi-Fi radiation.

But, as new emerging evidence continues to show some its detrimental effects, governments need to realize that we should not be bombarding everyone with these waves. Compared with radio waves emitted from a radio station, Wi-Fi stations can be really close to the body, especially working at laptops in schools or in our beside our bed when we sleep in our homes. Thus, it is suggested that, governments consider installing Wi-Fi free zones in and around sensitive sites such as schools until we do further research on its impact on health.

Acknowledgements

The author thanks the British Columbia Institute of Technology - Environmental Health for supporting this research.

Competing Interest

The authors declare that they have no competing interests.

References

- Austria Public Health Department. 2005. *Letter to parents*. Retrieved from <http://www.antennafreeunion.org/salzburg.pdf>
- Alberta Health. (2012). *Wifi in schools: Electromagnetic fields and cell phones*. Retrieved from <http://www.health.alberta.ca/documents/WiFi-In-Schools-2012.pdf>
- American Academy of Environmental Science. (2013). *Open letter to the superintendants of the school districts of the United States*. Retrieved from <http://aaemonline.org/images/WiFiUSA.pdf>
- Avendano, Conrado. (2012). Effects of laptop computers connected to the internet through wifi. *Fertility Weekly*, 97(1), 39-45. Retrieved October 20, 2013, from Academic Search Complete: ISN: 1086-1068.
- Austria Public Health Department. 2005. *Letter to parents*. Retrieved from <http://www.antennafreeunion.org/salzburg.pdf>
- Environmental Protection Agency. (2013). *Ionizing & non-ionizing radiation*. Retrieved from United States Environmental Protection Agency website: http://www.epa.gov/radiation/understand/ionize_nonionize.html
- Environmental Protection Agency. (2014). *EMF in your environment: Magnetic field measurements of everyday electrical devices*. Retrieved from <http://nepis.epa.gov/>
- Extech Instruments: A Flir Company. (2012). *RF EMF Strength meter Model 480846: Users guide*.
- Federal Communication Commission. (2013). *FCC advances procedures on RF safety rules*. Retrieved from website: <http://www.fcc.gov/encyclopedia/radio-frequency-safety>
- Gruber, Ben. (2009). *First wifi pacemaker in U.S. gives patient freedom*. Reuters. Retrieved from <http://www.reuters.com/article/2009/08/11/us-pacemaker-idUSTRE5790AK20090811>
- Health Canada. (2008). *What is ionizing radiation*. Retrieved from Public Health Agency of Canada website: <http://www.hc-sc.gc.ca/hc-ps/ed-ud/event-incident/radiolog/info/radiation-ion-eng.php>
- Health Canada. (2009). *Safety Code 6: Limits of human exposure to radiofrequency electromagnetic energy in the frequency range 3kHz to 300 GHz*. Retrieved from Public Health Agency website: <http://www.radiationsafety.ca/wp-content/uploads/2012/06/Safety-Code-6.pdf>
- Heacock, Helen. (2013). *ENVH 8400: Research Methods* [Class handout]. School of Health Sciences, British Columbia Institute of Technology, Burnaby, Canada.
- Hintze, Jerry. (2012). NCSS: Statistical software [computer software]. Utah: Kaysville
- Manzetti and Johansson, 2011. Radiation and Health. Australasian College of Nutritional & Environmental Medicine Journal. Retrieved from: <http://0-web.ebscohost.com/innopac.lib.bcit.ca/ehost/pdfviewer/pdfviewer?sid=1d1956b5-2f1b-472b-abf2-d1b971a8716d%40sessionmgr11&vid=8&hid=22>

Paehlke, Robert. (1995). *Conservation and Environmentalism: An Encyclopedia*. Retrieved from http://books.google.ca/books?id=9WUqqgfrBHQc&pg=PA371&lpg=PA371&dq=non+ionizing+electron+orbit&source=bl&ots=Ud00A170x&sig=DASRRxcqcvLtgazGuAbW42XE7IU&hl=en&sa=X&ei=iwveUv_zM9fmoASt44CYCA&ved=0CE8Q6AEwBw#v=onepage&q=non%20ionizing%20electron%20orbit&f=false

Public Health Agency of Canada. (2011). *Safety of wifi equipment*. Retrieved from Health Canada website: <http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/prod/wifi-eng.php#a1>

Savedge, Jenn. (2013). *Student science experiment finds plants won't grow near Wi-Fi router*. Retrieved from <http://www.mnn.com/health/healthy-spaces/blogs/student-science-experiment-finds-plants-wont-grow-near-wi-fi-router>

Sidhu, Bobby. (November 15, 2013). Interviewed by K. Minhas [notes]. Evaluation of EMF Radiation: Methods and Statistics, British Columbia Institute of Technology. School of Health Sciences, Burnaby.

University of Berkeley. (n.d). *Multiple hypothesis testing and false discovery rate*. Retrieved from <http://www.stat.berkeley.edu/users/hhuang/STAT141/Lecture-FDR.pdf>

Wifi Alliance. (2013). *Discover and learn*. Retrieved from <http://www.wi-fi.org/discover-and-learn>

WifiinschoolsAustralia.org. (2013). *Worldwide*. Retrieved from <http://www.wifi-in-schools-australia.org/p/worldwide.html>

World Health Organization. (2013). *What are electromagnetic fields*. Retrieved from <http://www.who.int/peh-emf/about/WhatisEMF/en/>

World Health Organization. (2013). *What is ionizing radiation*. Retrieved from http://www.who.int/ionizing_radiation/about/what_is_ir/en/

World Health Organization. (2014). *Electromagnetic fields and public health: radars and human health*. Retrieved from <http://www.who.int/peh-emf/publications/facts/fs226/en/>