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RESEARCH ARTICLE

CARBON FOOTPRINTS FROM MOBILE PHONE USE AMONG SCIENCE UNDERGRADUATE STUDENTS

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ABSTRACT

Considering the serious threat caused by mobile phone use, the study dealt with the determination of how much carbon footprints from the use of mobile phones among the Science undergraduate students of a state university in Central Visayas, Philippines are emitted in the atmosphere. This study utilized the non-experimental quantitative research method, particularly the survey method, to gather data on the number of hours of mobile phone use, and on the conservation practices of the student respondents. The equivalent carbon footprint (CO_2e) is obtained by converting the number of hours of phone use through the factor 57 g CO_2e per minute use. Study findings revealed that the respondents spent the most in texting with an average of 17.95 kg CO_2e per day. Application using, charging and calling contributed an average daily emission of 7.06 kg CO_2e, 6.10 kg CO_2e, and 1.78 kg CO_2e, respectively. Bluetooth-using produced the least emission with 0.49 kg CO_2e. These modes of use have implications in the educational setting, highlighting the need to adhere with significant educational theories and principles to maximize instructional time, rather than mobile use time. It was also found out that most students practiced conservation through reduction of mobile phone use, while 4% of them do not have mobile phones, and 9% do not have any conservation practices. Thus, the paper concluded that the students have affected the planet by contributing an annual emission of 84.71 tons kg CO_2e, or less than a millionth of the total global emissions. In accordance with the Kyoto Protocol, the students should reduce their mobile phone utility by 25-31 minutes per day. Students are gaining advocay in environmentalism, and eventually towards sustainable development.

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INTRODUCTION

Over the past years, the planet is experiencing anthropogenic advancements in science and technology, as what Stephen Hawking says posing a serious threat to the environment (Knapton, 2017). Such activities include the use of electronic devices which contributed to as approximately 1.4 billion tonnes (Gto) of carbon equivalent emissions in the year 2007 (Siegel, 2010), a value greater than the emissions yield by freezers, refrigerators and other conventional appliances combined (Hertwich, 2011). Mobile phones, in particular, were utilized around the world frequently, thereby giving off about 0.25% of the global emissions, which is equivalent to about 125 tonnes (Mto) in yerms of carbon footprints (Berners-Lee, 2010).

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This will still increase in the next years, in the Philippines for instance, since the number of Filipino mobile phone users has increased to approximately 102 million users in 2013, thereby emitting a greater amount of carbon dioxide in the atmosphere (Philippine Statistics Office, 2015).If such emissions are not regulated, the use of mobile phones can contribute to the increase accumulation of carbon emitted, making up 50% of the impact in the atmosphere as measured by Hierarchist Eco-Indicator '99 (Ministry of Housing, Spatial Planning and the Environment, 2000). Rising CO_2 accummulation in the air causes the planet to heat up, where mean global temperatures have increased by 0.8 degrees centigrade, according to National Aeronautics and Space Administration (n.d.). Too much of these can result to melting of ice at the poles, rising of sea levels, diminishing of coral reefs, and converting farmlands into deserts. Such simple activity on mobile phone use causes climate change (World Wildlife Fund-Philippines, 2007).With the inconvenient truths of the mobile phone industry, specifically its use, there is a need for a monitoring of the measure of carbon emitted called *carbon footprint*. Carbon

footprint is practicably defined as "a measure of the total amount of CO_2 and methane, CH_4, emissions of a defned population, and is measured as CO_2 equivalent using the relevant 100-year global warming potential". For simple reporting, it is often expressed in terms of the amount of CO_2 (Wright, Kemp and Williams, 2014). Additionally, CO_2 is converted into the amount of carbon emitted by multiplying with the factor 0.27 as 1 kCO_2 is equal to 270 g carbon. Such environmental footprints can be seriously understood in a certain university in the Philippines. The country is known for vulnerability of communities and localities due to threats caused by natural disasters, which is highlighted in the article "The Philippines, Victim of Climate Change". Understanding sources leading to such change is essential. Thus, the study deals with the quantification of carbon footprints from number of times mobile phones are used. Specifically, it seeks to determine the equivalent carbon dioxide, CO_2e, from the number of hours mobile phones are used in terms of charging, texting, calling, Bluetooth using and application using, and identify conservation practices to reduce carbon footprints in the environment.

Upon the accomplishment of the aims of the paper, the study would serve as an eye-opener for the students to realize their responsibility to the planet. Its significance lies in their awareness in the carbon footprints produced by just using mobile phones, and in finding ways to reduce such utility. Additionally, it provides rationale for schools and communities to adhere with such reduction, as well as to support cleaner technologies. Lastly, measuring carbon footprints is an appropriate way of calculating "how much" their activities have affected the planet.

MATERIALS AND METHODS

The study utilized the non-experimental quantitative research design. Specifically, survey method is employed to determine the number of hours the respondents utilize their mobile phones, and to identify their conservation practices to reduce carbon footprints. Two internal and one external professor in the Sciences field validated the research tool used. The study was conducted at a state university in Central Visayas, Philippines. The respondents are selected through purposive sampling, where the graduating Science students were chosen as respondents. A total of seventy respondents participated in the study. These respondents took up courses in the Education and Sciences colleges. Carbon emissions are quantified by converting the obtained data on the number of hours of mobile phone use to equivalent carbon footprints through the use of conversion factor as derived from Berners-Lee's (2010) book: a minute of mobile use emits approximately 57 g CO_2e. The values are calculated on daily basis, and approximately on annual basis.

RESULTS AND DISCUSSION

The Science undergraduate students spent most in texting with an average equivalent carbon footprint of 17.95 kg CO_2e per day. It was also noted that application using, charging and calling follow with an average of 7.06 kg CO_2e, 6.10 kg CO_2e and 1.78 kg CO_2e emissions daily, respectively. The students, moreover, spent the least in Bluetooth using, which is equal only to 0.49 kg CO_2e. Overall, the students used an average of 9.76 hours per day of mobile phone use, which emits and average of 33.38 kg CO_2e daily.

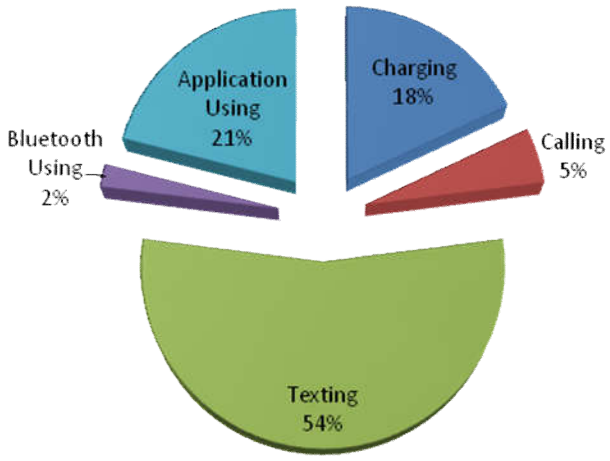

Fig. 1. Distribution of carbon footprints from the modes of mobile phone use

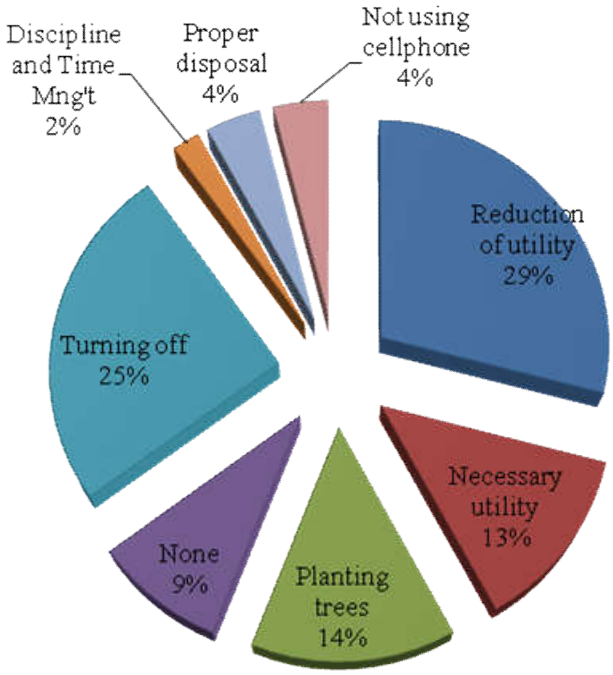

Fig. 2. Conservation practices on the use of mobile phones

This footprint value is equivalent to only about 0.039th of the footprints coming from digital terrestrial television viewing and about 0.11th from viewing videos using computers based on the findings of Chandaria, Hunter and Williams (2011). This suggests that mobile phone has less carbon footprint emission compared to other electronic devices used frequently in the school and households.

As shown in the Figure 1, texting contributed most to the carbon footprint emissions by mobile phone use. This means that the students keep on texting, which is usually done at an average of 5.25 hours per day. This frequency of texting inside school premises may be affected by the students' lack of interest, teachers' too un-updated teaching strategies, and the environment's unfavorable learning conditions. Instruction should address these factors to make learning relevant and meaningful to the students (Coe Aloisi, Higgins and Major, 2014), thereby making students focused on instruction rather than phone use. When this frequency is taken into a yearly

basis, texting would produce 6.55 tons of CO_2e emissions in the atmosphere. Though this emission combined with the rest of the world's emission, at 32,000 tons CO_2e, is miniscule, but the increasing number of texters around the globe may contribute to the increasing CO_2 accumulation in the atmosphere (Breslin, 2016).

Moreover, students use their mobile phones through application using for 2.05 hours daily. To note, Science students use applications as means to communicate with each other thru instant messengers, to browse for references in hardcore sciences such as Cell Biology, Analytical Chemistry and Modern Physics, and to play games in vacant periods. Mobile applications offer a range of significant opportunities to, not only for leisure, but also for student learning (Mehdipour and Zerehkafi, 2013). Though deemed beneficial for 21st century learning, too much engagement in phone applications could cause problems in education, including probable increase in app time rather than instructional time (Jesse, 2015). Beyond that, mobile application using yields 2.58 tons CO_2e annually. This is a small contribution to the carbon footprinting, however, the emissions from the use of the available millions of applications in smartphones (https://www.statista.com/) could add to the increasing footprints in the environment.

Following the emissions of texting and application using are the footprints coming from charging and calling, which are done by students for 1.76 hours and 29 minutes per day, respectively. Students charge their phones approximately within the charging time intended for lithium-polymer batteries, greatly increasing safety performance of the phone (Jian and Yixian, 2016). However, analysis of the measurements at Berkeley National Laboratory showed that overcharging could waste energy, giving off 30% more CO_2e than optimal charging (http://standby.lbl.gov/ summary-table.html). Calling through mobile phones also give off carbon emissions in the atmosphere, but the emission is very small as shown in the Science students' emission of a kilogram footprint per day. Though the mobile phone use is a form of communication, an article in *The Wall Street Journal* stated that calling is seldom used by millenials practically due to texting being more efficient in accomplishing a task (Hofschneider, 2013) and when there are different time availabilities (Golwalkar, Vaniyamparambath, Palan and Wang, 2016). Nevertheless, charging and calling contribute a total of 2.88 tons CO_2e, a footprint value small in environmental sense, but a great area for improvement in education for sustainable use and social affairs.

The least among the modes of phone use is Bluetooth using and other 'sharing' application using. The 11-minute sharing of files, music or videos implies that students have less time in interaction with their classmates and friends. The article in *Borderzine* stated that people seems to be more comfortable to texting rather than actually talking or interacting with one another (Marquez, 2009). With this, students are more interested with the people not present.

The total annual carbon emissions from the mobile phone use in the perspective of the Science undergraduate students produced a total of 847,193.08 kg CO_2e or about 84.71 tons of equivalent. This is equivalent only to 0.00000068% of the total carbon emissions in the year 2007. This may be a tiny portion of global emissions, but if students are using their mobile phones every hour, they can add up to more than 1 tonne CO_2e per year, which corresponds to flying from London to New York (Berners-Lee, 2010). It means that they have contributed to the emissions in the atmosphere, considering that it was 2007, which of course is increasing up to this year.

If the state university will adhere with Kyoto Protocol, of which the Philippines is a convention party, it should be noted that the educational institution should reduce the carbon emissions by 4.2% to 5.2% per year (Olivier and Janssens-Maenhout, 2011). Considering the total amount of carbon emissions from the use of mobile phones, the undergraduate students should lower the hours used by 25-31 minutes average per day. Thus, it is implicated that the students should have reduction on the time used, and concentrate on other things to do which is more sustainable and conservative to the environment.

About twenty-nine percent of the Science undergraduate students practice conservation through reduction of the utility of mobile phones, and about 25% through turning off their phones. Decrease in the use of the mobile phones could lead to greater instructional time rather than mobile phone use time, which may address some problems concerning the use of electronic devices inside the classroom (Beland and Murphy, 2015). Like switching off lights and turning off televisions, turning off mobile phones could save electricity consumption, reduce the amount of carbon emissions up to 60%, and decrease the CO_2 buildup in the atmosphere (Imperial College London, 2010).

Necessary utilization of mobile phones is practiced by 13% of the students. Responsible use of mobile phones in schools provides avenues for better decision-making and a development of a pro-social culture of digital technology use (New Zealand Ministry of Education, 2015). Efficiency in utility could save pounds of CO_2 in a year, as exemplified in the emission of other electronic device's efficient use (World Health Organization, 2008).

Furthermore, 4% of the respondents dispose phones properly, 2% employ discipline and time management, 4% do not have mobile phones and 9% do not have any conservation practices concerning the use of these phones. Finally, it is noted that about 14% of the Science major students tend to plant more trees to reduce carbon footprints. These students come mostrly from Biology program, and specifically, bamboo is recommended for planting because it has potential in reducing such carbon sequestration capacities (INBAR, 2005). Also, they practice the proper disposal of phone products which is very environmental in sense. For this, it is inferred that a considerable percent of the students are gaining advocacy for the environment, and eventually towards sustainable development.

CONCLUSION AND RECOMMENDATIONS

The Science undergraduate students yielded 84.71 tons CO_2e or about less than a millionth of the total global emissions.The study recommends to reduce the mobile phone use among the students by 25-31 minutes average per day in order to adhere with the Kyoto Protocol of the United Nations. Moreover, more environmental practices are encouraged to have a more eco-friendly means of affecting the planet. Finally, the students should be given more awareness and information about

sustainable development, for them to reflect their actions in a more interdisciplinary perspective.

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