Does Climate Change Education Result to Less Carbon?

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Abstract This study aimed to determine the climate change knowledge and measure the individual carbon footprint of 164 Grade 10 students who were randomly selected from two highly urbanized and two less urbanized schools in the Philippines. The study also investigated the demographic factors that were previously found to affect the amount of carbon footprint. A 20-item test was used to measure climate change knowledge while the Philippine version of World Wildlife Fund's (WWF) carbon footprint calculator was used to measure individual carbon footprint. Response pattern of the climate change knowledge test was analyzed and carbon footprint was computed for each participant. One-way Analysis of Variance was used to determine the influence of demographic factors on individual carbon footprint. Results show that the participants were "moderately knowledgeable" about climate change. Meanwhile, their mean carbon footprint (1.20 metric tons per capita per year) is slightly higher than the 2014 Philippine average (1.1 metric tons per capita per year) which suggests that being knowledgeable on climate change does not necessarily result to lower carbon

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footprint. Results of the study likewise show that among the demographic factors investigated, only parents' highest educational attainment (p= 0.000), level of urbanization (p= 0.002), and household income (p= 0.044) influence individual carbon footprint. It is recommended that in teaching the science of climate change, the social, political and ethical dimensions of the issue may be emphasized. The topic may also be discussed in the context of Education for Sustainable Development to engage students in concrete carbon reduction initiatives.

Keywords: carbon footprint, climate change education, parents' educational attainment, household income, levels of urbanization

Introduction

There is a current gap between scientific and societal understanding of climate change (Ledley, Rooney-Varga, & Niepold, 2017). Therefore, addressing climate change effectively requires quality climate change education. While climate scientists and environmentalists know very well the science behind climate change, the common people have very limited understanding about it (Leiserowitz, Smith, & Marlon, 2010) and one way to increase public awareness and understanding of climate change is through appropriate climate change education (Ledley et al., 2017).

Climate change education (CCE) is the transfer and use of knowledge to prepare people to engage in climate change discourse critically and accurately (Chang & Pascua, 2017). As UNESCO (2017) puts it, education is an essential global response to climate change. Through its Climate Change Education for Sustainable Development program, UN member states are mandated to provide quality climate change education and to increase "climate literacy." Schools

are likewise encouraged to integrate climate change education and shall promote climate change awareness through formal instruction.

The State of Climate Change Education

Introduction of climate change education in the school curriculum resulted to improved student knowledge, awareness and concern towards climate change (Chang, 2014). In UK, Years 5 and 6 students who received climate change lessons developed positive attitude and behavior towards climate change. Though a deep understanding of climate change concepts was not evident, positive knowledge gain was observed (Chang, 2014). Similarly, Year 6 Australian students claimed to have understood the causes and impacts of climate change after they were given formal instruction. They likewise acquired an increased level of concern and were positive that they can make optimistic impact to global warming and climate change (Taber & Taylor, 2009).

Additionally, Chang and Pascua (2017) reviewed papers from Finland, Hong Kong and Malaysia which examined students' awareness, perceptions, attitudes, and behaviors towards climate change. It was found that Finnish students considered the issue of climate change as relevant to their lives but do not show willingness to act about it. Hong Kong students also showed concern about climate change and demonstrated high level of awareness and attitude towards climate change. The study conducted among Malaysian students revealed that experiential learning can help students acquire knowledge on climate change.

On the other hand, random studies with students who were not given formal instruction on climate change yield opposing results. Kilinc, Stanisstreet, and Boyes (2008) reported that Turkish students have flawed understanding about global warming. In a survey with Spanish students, Punter,

Ochando-Pardo, and Garcia (2011) found that students seemed unaware about the socio-economic problems brought about by climate change. It was also evident that said students do not have a clear understanding of climate change. Also, a study by Shepardson, Niyogi, Choi and Charusombat (2009) revealed that American seventh graders lack a rich conceptualization about climate change. In the Philippines, not a single study on climate change knowledge of students is available online. The only data available is the World Bank (2013) report which revealed that 8 out 10 adult Filipinos have personally experienced the effects of climate change which suggests that Filipinos are aware about the issue.

The State of Climate Change Education in the Philippines

Section 3 of Republic Act No. 9512 or the National Environmental Awareness and Education Act (Official Gazette, 2008) stipulates that, "The Department of Education (DepEd), the Commission on Higher Education (CHED), the Technical Education and Skills Development Authority (TESDA), the Department of Social Welfare and Development (DSWD), in coordination with the Department of Environment and Natural Resources (DENR), the Department of Science and Technology (DOST) and other relevant agencies, shall integrate environmental education in school curricula at all levels, whether public or private, including barangay daycare, preschool, non-formal, technical vocational, professional level, indigenous learning and out-of-school youth courses or programs." In compliance with the law, the K to 12 Science Curriculum Guide of the Department of Education (2013) listed "Climate" (p. 54) as one of the topics in the third quarter of Grade 9. Under the main topic are two subtopics which are shown in Table 1.

Based on the curriculum, Grade 9 students should already have a clear understanding of the science of climate change including its effects and adaptation strategies as shown

in the content standard. Likewise, students were also expected to participate in activities that reduce risks and lessen the effects of climate change as stipulated in the performance standard.

Table 1. Climate Change as a Topic in Grade 9 Science

Content	Content Standards	Performance Standards	Learning Competency
Climate 1. Factors that affect climate 2. Global climate phenomenon	Factors that affect climate, and the effects of changing climate and how to adapt accordingly	Participate in activities that reduce risks and lessen effects of climate change	1. Explain how different factors affect the climate of an area 2. Describe certain climatic phenomena that occur on a global level

Also, Ho and Seow (2017) reported that climate change is also discussed in the Social Studies course. The Filipino teachers who were part of the qualitative study claimed that they discussed the topic in their History class. The discussion focused on how climate change affects human history and how humans affect the environment. Clearly, the integration of climate change in Social Studies focused on the "citizenship education and civic efficacy component within climate change education but paid far less attention to climate change science" (Ho & Seow, 2017, p.247).

In sum, Philippine basic education curriculum has already introduced climate change education. Curriculum document shows that the science of climate change and its related concepts, effects and adaptation strategies are discussed in Grade 9 Science. Literature also show that the topic is presented in an "interdisciplinary social studies perspective" (Ho & Seow, 2017, p.240).

Climate Change Education and Individual Carbon Footprint

Climate change education should not only result to improved knowledge, attitude and perception and increased awareness towards the issue of climate change. Knowledge

should be transformed into concrete actions towards mitigating the effects of climate change or reducing the amount of individual carbon emission or footprint. For instance, the European Commission (2009) report on Europeans' attitudes towards climate change highlighted that well-informed citizens are more likely to take action than the ill-informed ones. Further, "those who think that climate change is a very serious problem are considerably more likely to have taken personal action aimed at fighting climate change than those who do not think it is a serious problem" (p.30). Yet, Ledley et al. (2017) posit that acquiring knowledge about climate change does not always lead to action. True enough, Csutora (2012) found that positive environmental awareness did not result to lower carbon footprint among Hungarian participants. In New Zealand, students were aware of tourism's contribution to climate change, but it did not appear to have any influence on their travel-related decisions (Tiller & Schott, 2012). In a survey conducted among Czech adolescents, Skalik (2015) found no clear association between awareness and level of consumption.

Factors that Affect Individual Carbon Footprint

Carbon footprint is defined by Vidallo, Gonsalvez, Oro, Dalusag, Barbon, Jordan, Rosimo, Romero, Servano, Baguila, Rosales, Narte, Purdon, Narte, Bernales, Navarra, and Sebastian (2015) as the total greenhouse gas emissions that directly or indirectly support human activities, expressed in tons of carbon dioxide. The average individual carbon footprint of every Filipino is 1.1 metric tons (The World Bank, 2014). Individual carbon footprint may be computed using the carbon footprint calculators available in World Wildlife Fund (WWF) websites. The WWF-Philippines carbon footprint calculator considers four parameters, namely: transportation, liquefied petroleum gas, electricity and wastes. Empirical studies conducted in UK, US, Germany and China revealed that carbon footprint is influenced by demographics such as

gender (Druckman, Buck, Hayward, & Jackson, 2012; Meier & Christen, 2012), household size (Lin, Yu, Bai, Feng, & Wang, 2013), household income (Weber & Matthews, 2008; Golley & Meng, 2012), and level of urbanization (Heinonen & Junnila, 2011) affect carbon emissions.

As presented, climate change education is an important climate change initiative. It is also apparent that the Philippine educational system has been responsive to the call for the inclusion of the topic in the basic education curriculum. But, it appeared that no study has been published yet reporting the climate change knowledge of Filipino students who supposedly have been given formal instruction on the topic in their Science class. Hence, this study was conceptualized. The present study also investigated whether climate change knowledge of students necessarily results to lower carbon footprint. The different factors that affect individual carbon footprint were likewise explored.

Purposes of the Research

The study specifically sought answers to the following:

1. What is the climate change knowledge of the participants?
2. What is the individual carbon footprint of the participants?
3. Is there a significant difference in the individual carbon footprint when grouped according to the levels of knowledge on climate change?
4. Is there a significant difference in the individual carbon footprint of the participants when grouped according to demographics such as gender, household size and household income, parents' highest educational attainment, and level of urbanization?

Methodology

Research Design

This study utilized cross-sectional, explanatory research design (Johnson, 2001). The design is used to refer to a study whose "data collection is done in a single and brief period of time… and researchers are trying to explain how a phenomenon operates by identifying the causal factors that produce change in it" (p.9). In the present study, the researchers tried to explain the relationship between climate change knowledge and individual carbon footprint and identified the demographic factors that cause a change on the amount of carbon footprint. Data collection was also done at one time period in each school. Hence, cross-sectional, explanatory is the most appropriate design for this study.

Research Locale and Participants

Four schools were chosen because of their accessibility. Schools A and B are situated just within the highly urbanized area of Metro Manila (see Figure 1). School A is a Philippine Accrediting Association of Schools, Colleges and Universities (PAASCU) Level 3-accredited sectarian private school located in the City of Manila, while School B is a public high school located in the City of Taguig. Schools C and D are both located in the less urbanized city of Laoag, Ilocos Norte. School C is a non-PAASCU-accredited, non-sectarian private school located at Brgy. 2 while School D is a public high school located at Brgy. Caaocan. Both barangays are located just within the city limits.

The one-hundred sixty-four (164) participants were randomly selected from among the Grade 10 sections of the participating schools. The sample is a mere 6.3% of the population. The chosen participants were given questionnaires and those who were not permitted by their parents were

replaced to achieve an equal proportion of participants in terms of gender (82 male, 82 female) and level of urbanization (82 students highly urbanized communities, 82 students from less urbanized communities). Most of the participants live with 4 (23.8%) to 5 (23.8%) other persons at home. In terms of income, most of them earned below Php40000 a month (52.4%). The participants have parents who are mostly college graduates (49.4%) and majority of them (98.8%) received formal instruction on climate change as given in their previous science class. Outside of school, many of the participants were informed about climate change through lectures (32.9%) and TV programs (24.4%).

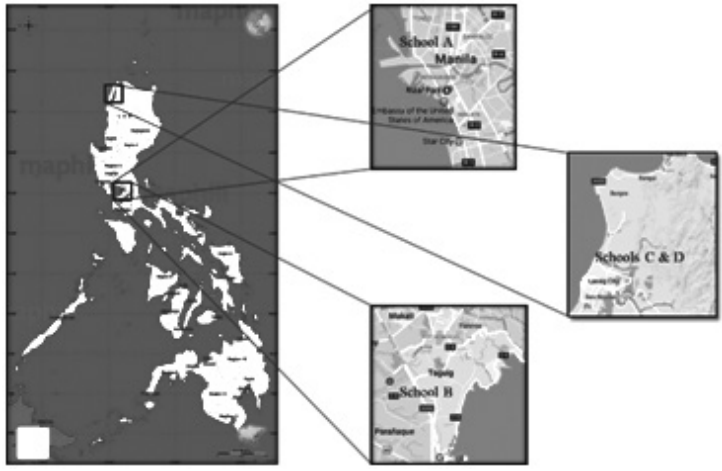

Figure 1. Study Areas.

Instruments

Basic Survey Questionnaire. This questionnaire (see Appendix A) asks for the participants' demographics such as gender, household size, household income, and parents' highest educational attainment. It also requires participants to indicate whether climate change was discussed to them in the previous grade levels as well as their involvement in climate change-related activities.

Climate Change Knowledge Test. This test (see Appendix B) is a modified version of the *Knowledge on Climate Change Survey Questionnaire* by Leiserowitz et al. (2010). It was originally developed for the Yale Project on Climate Change Communication which aimed to assess Americans' knowledge on climate change. From 55 items, it was trimmed down to 20. Items that do not apply to Philippine context were removed. Yes-No questions were likewise transformed into True-False. Hence, the final test consisted of 20-item combination of multiple choice and true or false questions. A score of 1 is assigned to every correct answer and 0 for every incorrect answer. Face validation of the questionnaire was carried out by two science education experts: science education professor and science coordinator of School A. Reducing the number of test items has resulted to a lower internal consistency ($\alpha = 0.450$) of the test for the sample. Despite its low reliability index, the researchers still utilized the test since in the face validation, the experts concurred that all items of the test relate to or measure students' general knowledge about climate change.

Carbon Footprint Calculator. The Philippine version of the Carbon Footprint Calculator developed by World Wildlife Fund (2006) was used to measure individual carbon footprint (see Appendix C). The calculator is available online in the link provided in Appendix C. The calculator comes in a formula-enabled spreadsheet format. It has five sheets namely, *Carbon Footprint Calculator, My Carbon Footprint, Flight Distance, Calculation Table, Country Benchmark and Sustainability*. Values were encoded in the *Carbon Footprint Calculator* sheet. The four other sheets served either as outputs sheet or reference. Input sections include *About You, Your Home, Transport-Flight, Transport-Land*, and *Waste*. Once completed, the calculated carbon footprint of the participant (in tons of CO_2 per year) was shown in the upper right hand corner of the *Carbon Footprint Calculator* sheet. The *My Carbon Footprint* sheet provided the reference values and corresponding interpretation. Individual

carbon footprint is computed by adding the carbon emissions in four different areas, namely Transport, LPG, Electricity and Waste. The sum in kg is then divided by 1000 to compute the individual carbon footprint in metric tons.

Data Collection

Permission was sought from the campus administrators of the four Junior High Schools. Arrangements such as schedule of distribution of questionnaires and test administration were negotiated directly to the teachers concerned. Parents' consent was likewise sought considering that the participants were mostly minors. The participants with unsigned consent forms were excluded from the study. Data collection was done in the respective schools during science classes.

A basic questionnaire was first distributed to gather the participants' demographics and information on how they acquired their knowledge on climate change aside from their science class. Specifically, the participants identified the type of their school, gender, household size and income, parents' highest educational attainment. They were also asked to confirm if climate change was discussed in their previous classes and identified the climate change-related activities they attended.

The climate change knowledge test was administered to determine how much the participants know about the science of climate change. The test is a combination of true-false and multiple choice items about climate change, its causes, effects and mitigation strategies. The participants answered the test by checking on the space provided before the option.

The Philippine version of the Carbon Footprint Calculator was used to measure the participants' individual carbon footprint. The spreadsheet was printed and brought home to allow the participants to seek help from any household member (preferably parents) on items that they were expected

to know little about such as household energy consumption, *etc*. The accomplished Carbon Footprint Calculator were collected after two days.

Data Analysis

Profile of participants was presented in percentages. Data from the basic survey questionnaire and climate change knowledge were analyzed using descriptive statistics. The individual carbon footprints were obtained using the Carbon Footprint Calculator of the World Wildlife Fund. Each was then categorized using the scale in Table 1:

Table 2. WWF categories of individual carbon footprint level

Carbon footprint *(in tons of CO_2 per year)*	**Level**
0-0.99	Low
1.0 – 3.99	Average
4.0 – 12.40	High
12.41 +	Very high

One-way Analysis of Variance (ANOVA) determined the influence of gender, household size, and household income, parents' highest educational attainment, and level of urbanization (herein referred to as factors), each with two or more categories to the single dependent variable which is individual carbon footprint. IBM Statistical Package for the Social Sciences (SPSS) version 23 was used in the statistical analyses.

Results and Discussion

This section presents the climate change knowledge and individual carbon footprint of the participants. The difference of the individual carbon footprint of the participants in terms of gender, household size and household income, parents' highest

educational attainment, level of urbanization, and levels of knowledge on climate change are likewise presented.

Climate Change Knowledge

Climate change knowledge describes Grade 10 students' understanding about climate change as a topic that was discussed to them in the previous grade level.

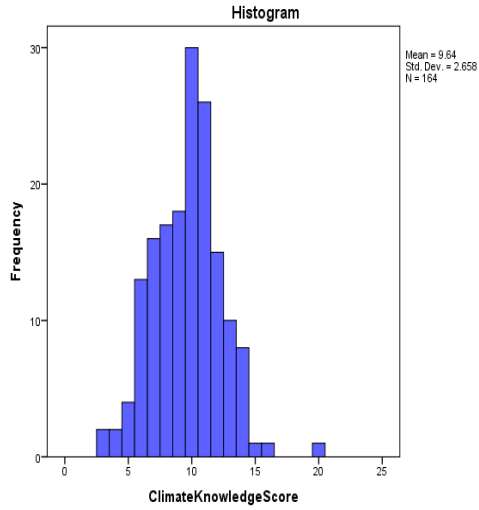

Figure 2. Histogram of Climate Change Knowledge Scores.

Figure 2 shows that most of the scores aggregate within the midpoint and show low variability (M=9.64, SD=2.658, N= 164). The lowest score is 3 while the highest is 20. The result indicates that the students have acquired knowledge on the science of climate change and its related concepts. This also suggests that they have developed awareness about the issue. Nevertheless, the result is not surprising considering that all questions simply pertain to climate change and its related concepts which was previously tackled few months ago in the third quarter of their Grade 9 Science. Aside from the class discussion, the participants were also informed about climate change through lectures (32.9%) and TV programs (24.4%).

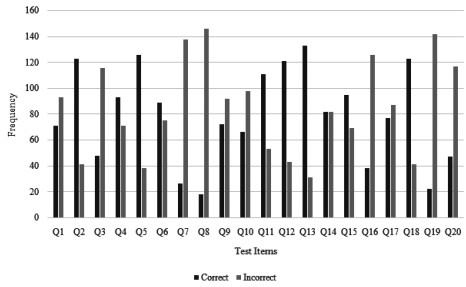

Figure 3. Per-question Responses.

The proportion of right and wrong answers of the participants in Figure 3 shows that only few were able to correctly answer Questions 8 (11.0%), 19 (13.4%) and 7 (15.9%). As shown in Table 3, all the three questions require exact answers such as actual amount of carbon dioxide in the atmosphere (in parts per million) and height of sea level rise (in inches). Result shows that students have not retained the figures in their short-term memory considering that the lesson on climate change was given to them at least a year ago. While the science of climate change may have already been discussed, it is also possible that topics such as amount of carbon emissions or sea level rise may have not been tackled or emphasized. This is also attributable to the fact that like "carbon footprint", the said topics were not explicitly listed in the K to 12 Science Curriculum Guide (Department of Education, 2013, p.54). The content and performance standards for the topic "Climate" are: "*Factors that affect climate, and the effects of changing climate and how to adapt accordingly*" and *"Participate in activities that reduce risks and lessen effects of climate change"* which suggest that "carbon footprint" should have been introduced so that students could identify how they were able to contribute to climate change and how they should help in mitigating its effects. On the contrary, Questions 2 (75.0%), 18 (75.0%), 5 (76.8%), and 13 (81.0%) were answered correctly by the

majority. This result shows that the concept of greenhouse effect, climate change and the factors that trigger the increasing rate of the change were emphasized when they discussed the topic in the previous grade level.

Levels of Climate Change Knowledge

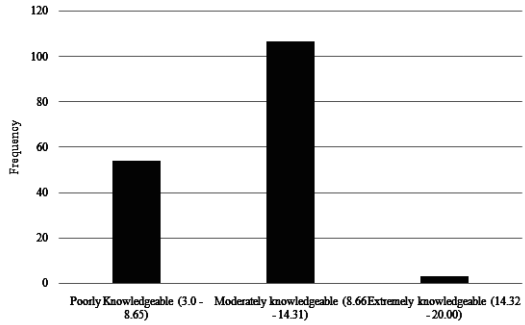

Figure 4. Level of Climate Change Knowledge.

Most of the responses (62.5%) fall within the "moderately knowledgeable" level (8.66 – 14.31). Result suggests that majority of the participants have developed at least fair understanding about the science of climate change. Only 1.8% of the participants reached the "extremely knowledgeable" level. This indicates that only few were able to develop mastery of the topic. As shown in the curriculum guide, two weeks were allotted for the two learning competencies: 1) explain how different factors affect the climate of an area and 2) describe certain climatic phenomena that occur on a global level. Time would have been enough for students to further dissect the issue of climate change in activities like debate and panel discussion. Three up to five days of the two-week time allotted for the discussion of the topic may have been utilized in giving students some web-enhanced learning activities such as WebQuests and Treasure Hunts. The rich and up-to-date online resources on climate change may have supplemented the learner's material or the limited number of print materials in the library. To further ensure that students will develop mastery of

the topic, authentic learning activities such as measuring their own carbon footprint and making a personal action plan out of it would have helped.

Table 3. Climate Change Knowledge Questions vis-à-vis K to 12 Science Curriculum Guide

Content*	Content Standards*	Learning Competency*	Questions**
Climate		1) Explain how different factors affect the climate of an area	1. What is global warming? 2. The "greenhouse effect" refers to:
1) Factors that affect climate 2) Global climate phenomenon	Factors that affect climate, and the effects of changing climate and how to adapt accordingly	2) Describe certain climatic phenomena that occur on a global level	3. Which of the following does NOT affect the average global temperature of the Earth? 4. Which of the following gases in the atmosphere are good at trapping heat from the Earth's surface? 5. Which of the following are "fossil fuels"? 6. What gas is produced by the burning of fossil fuels? 7. To the best of your knowledge, roughly how much carbon dioxide was in the atmosphere in the year 1850? 8. Roughly how much carbon dioxide is in the atmosphere today? 9. How will you describe the amount of carbon dioxide in the atmosphere has changed over the past 500 years? 10. If we were to stop burning fossil fuels today, the amount of carbon dioxide in the atmosphere would decrease almost immediately. 11. If we were to stop burning fossil fuels today, global warming would stop almost immediately. 12. Of the following, which one do you think contributes most to global warming? 13. The Earth's climate has changed naturally in the past, therefore humans are not the cause of global warming.

14. Global warming will cause temperatures to increase by roughly the same amount in all countries.

15. Any recent global warming is caused by the sun

16. Which of the following causes coral bleaching?

17. Which of the following statements is correct?

18. Over the past 100 years, has the speed of glacier melting increased, decreased, or stayed the same?

19. If no additional actions are taken to reduce global warming, how much do you think global sea levels will rise by the year 2100?

20. Which of the following causes ocean acidification?

**From the K to 12 Science Curriculum Guide (December 2013 version)*

***Adapted from Knowledge on Climate Change Survey Questionnaire by Leiserowitz et al. (2010)*

Individual Carbon Footprint

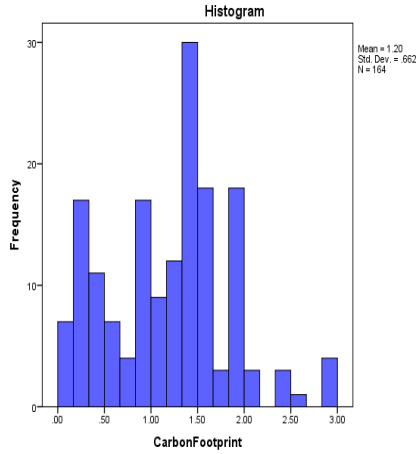

Figure 5. Individual Carbon Footprint of Participants.

Carbon footprint refers to the total greenhouse gas emissions that directly or indirectly support human activities, expressed in tons of carbon dioxide (Vidallo et al., 2015). The carbon footprint of the participants ranges from 0.02 to 2.98 tons of CO_2 per year which then averages at 1.20 tons of CO_2 per person a year. The figure is slightly higher than the Philippine average of 1.1 metric tons per capita, an estimate published by The World Bank (2014). Yet, it should be noted that the computed mean still falls within the "Average" level (1.0 – 3.99) based on the scale of the World Wildlife Fund (2006). The 2014 World Bank report also showed that every American emits 16.5 metric tons of CO_2 per year. ASEAN countries such as Singapore, Malaysia and Thailand have even higher per capita emissions than the Philippines which are estimated to be at 10.3, 8.0 and 4.6 per person per year, respectively.

This result is explained by the fact that the majority of the participants were seldom engaged in long distance travels as shown in the data. Their carbon emission from transportation is primarily produced from the daily home-school-home travel. Also, most of them took the public transport in going to school. Though a few of them own cars, they claimed that they do share the ride with one or two other family members. It was also noticed that only few of the participants traveled via air.

Influence of Levels of Climate Change Knowledge on Individual Carbon Footprint

Levels of climate change knowledge do not affect individual carbon footprint (see Table 4) which implies that the "moderately knowledgeable" level of climate change knowledge of the majority of the participants did not necessarily result to a change in the individual carbon footprint. This result validates the findings of Csutora (2012) that the varying levels of commitment to pro-environmental behaviors of Hungarian participants do not affect their carbon footprint. Similarly,

Ledley et al. (2017) argued that knowledge does not necessarily move people into carbon emission reduction. Tiller and Schott (2012) likewise reported that climate change knowledge does not necessarily translate into concrete climate change adaptation strategies. Furthermore, the findings suggest that the teaching of climate change in the K to 12 Science Curriculum should be strengthened. In other words, teachers need to look for new and innovative ways in delivering the topic in order to translate knowledge and awareness into carbon footprint reduction initiatives. Aside from discussing the science behind climate change, Ledley et al. (2017) recommend that climate change education must be reinforced with affect, beliefs, intentions, and motivation to enact change in order to bring people to action.

Influence of Participants' Demographic Profile on their Individual Carbon Footprint

Gender

Gender does not affect individual carbon footprint as shown in Table 4. This is contrary to the result of Druckman et al. (2012), which found that man's higher average carbon footprint as compared to a woman is due to leisure activities. In another study, Lynch (2011) found that males have higher (10.1-100 metric tons of CO_2) total direct carbon emissions compared to females (0.1-10.0 metric tons of CO_2). In the present study, having no difference in carbon footprint between the two can be explained by the almost similar activities that they do every day as students such as studying, going to school, among others. All other gender-specific activities do not cause a significant increase in their carbon footprint.

Table 4. Difference of Participants' Individual Carbon Footprint in Terms of Demographic Profile and Climate Change Knowledge

	Sum of Squares	df	Mean Square	F	Sig.
Gender	.673	1	.673	1.541	.216
Household size	4.326	6	.721	1.686	.128
Household income	4.238	4	1.06	2.507	.044*
Parents' educational attainment	15.885	7	2.269	6.371	.000*
Level of urbanization	3.959	1	3.959	9.504	.002*
Level of knowledge on climate change	1.919	2	.96	2.222	.112

**Significant at .05 level of significance.*

Household size

The participants' individual carbon footprint is not affected by household size (see Table 4). This result is contrary to that of Lin et al. (2013), and Weber and Matthews (2008) who argued that eco-efficiency increases with an increase in household size. The result of the present study suggests that in the Philippine society where extended family type is common, the number of household members does not have an influence on individual carbon footprint of a single household member. This finding further implies that the activities of a single family member does not increase or decrease individual carbon footprint of other family members.

Household income

Household income affects individual carbon footprint (see Table 4). Post hoc comparisons indicate that the income falling under Php40000 is significantly different from those

with Php40000 to Php59999 income. This result is consistent with the findings of Weber and Matthews (2008) and Golley and Meng (2012). According to Golley and Meng (2012), together with expenditure, household income is a good predictor of domestic CO_2 impact. They also found that rich households generate more carbon footprint per capita than poor households. From this result, it is empirical to say that in the Philippine society, households with a total monthly income of Php59999 are likely to have higher carbon footprint than families with income below Php40000. This can be explained by the fact that well-off households can afford expensive lifestyles which often result to high level of energy consumption. They do not take public transport and are likely to use their own cars even in short distance travels. They also have the tendency to generate more wastes than low income families.

Parents' Educational Attainment

Lee, Markowitz, Howe, Ko, and Leiserowitz (2015) reported that educational attainment is the single strongest predictor of climate change awareness. In the present study, parents' highest educational attainment significantly affects individual carbon footprint (see Table 4). Post hoc comparisons show that high school graduates differ significantly from college graduates. Being aware about climate change, parental decisions on energy consumption and lifestyle must have affected significantly the overall carbon footprint of the participants. High school and college graduate parents will likely have different climate change related decisions. Parents with higher levels of education are expected to have a better grasp of environmental issues such as climate change compared to those with lower amount of education. At the same time, college graduate parents are expected to have landed in white-collar jobs and hence, have higher income. Consistent with the result of the present study (higher household income will likely result to higher carbon footprint), the difference in the carbon footprint of high

school and college graduate parents can be explained by the higher carbon footprint of the latter than the former.

Level of Urbanization

Results show that individual carbon footprint is affected by the level of urbanization (less urbanized or highly urbanized) of the communities where the participants reside F (1, 162) = 9.504, p=.002. Similarly, Heinonen and Junnila (2011) found a difference in the per capita carbon emissions of cities and rural areas in Finland. It also agrees with the result of a study in Beijing which found that urbanization level plays a positive role in promoting carbon emission (Zhang, Yi, & Li, 2015). In the Philippines, households in highly urbanized areas live more sophisticated lifestyle than those in the provinces. This is evidenced by the higher energy consumption and waste generation of households in highly urbanized area than in less urbanized area.

Conclusion

This study determined the climate change knowledge and individual carbon footprint of Grade 10 students who received formal instruction on climate change in the previous grade level. It also investigated the demographic factors such as gender, household size and household income, parents' highest educational attainment, and level of urbanization that were previously reported to affect the amount of carbon footprint. As previously mentioned, the present study may have been the first of its kind in the Philippines considering that at the moment, not a single study that reported the engagement of Filipino students in climate change education could be found in online journals. In short, findings of this research may have just provided a glimpse of the status of climate change education in the Philippines in terms of students' climate change knowledge.

In general, the students were moderately knowledgeable about the science of climate change, an indicator that the topic was indeed discussed in class. The result indicates as well that the students were aware about the issue of climate change. Meanwhile, the individual carbon footprint of the students (which is slightly higher than the Philippine average) implied that climate change education have not led to carbon reduction initiatives. This was confirmed by the result of the statistical analysis in which levels of climate change knowledge do not affect the amount of individual carbon footprint. This was further supported by Ledley et al. (2017) who argued that climate change knowledge does not always lead to concrete action. To ensure that climate change education will move individuals into action, knowledge must be paired with affect, beliefs, intentions, and motivation to enact change.

Result of this study likewise showed that parents' highest educational attainment, level of urbanization and household income significantly influence individual carbon footprint. This implied that parents have important roles to play in reducing their children's carbon emission. It is then suggested that parents be made part of the climate change education program of schools and the government in general. Considering that students from highly urbanized area have significantly higher emission than the less urbanized, it is suggested that schools in highly urbanized areas teach not only the science of climate change but present as well the social, political and ethical dimensions of the human-induced climate crisis. Climate change may also be discussed in the context of Education for Sustainable Development (ESD), for instance, to shed light on the fact that while income is a measure of economic prosperity, it does not always translate into a sustainable climate change-resilient society. Societies are affected by climate change's impacts on social, cultural, and natural resources (US Environmental Protection Agency, 2016). According to PAGASA (2011), impacts of climate change are now felt in the Philippines. More intense El Niño events,

increased sea surface temperature, ocean acidification, sea level rise, stronger typhoons, and increased amount of rainfall that will in turn result to river inundations (Ranada, 2015) are just a few manifestations of the changing climate in the country.

It appears that the environmental problem that threatens present societies is in fact created by societies themselves. The UN Intergovernmental Panel on Climate Change's (2014) Fifth Assessment Report has already concluded with 95% certainty that the increasing level of greenhouse gas concentration in the atmosphere is human-induced. With this, all climate change mitigation initiatives should aim at reducing anthropogenic carbon emission. Having been identified as one important climate change initiative, the ultimate aim of climate change education in schools must be to lower carbon footprint among students. However, it is quiet disturbing that the result of the present study does not seem to support this goal. Thus, the most logical thing to do at the moment is for the Philippine government thru the Climate Change Commission, Department of Environment and Natural Resources and Department of Education to review the existing curriculum particularly on how climate change is taught. Ways on how the society in various capacities can contribute in solving the problem it created may also be made part of the learning competency for the topic.

Recommendations

This study is just an initial step in investigating the climate change knowledge of students in the Philippines. Primary weakness of the present study is its limited sample size which obviously is not representative of the entire population of Filipino students. The researchers also failed to supplement the quantitative data with qualitative data sourced from conversations with teachers and students that may have helped explain some parts of the results.

Some issues have been identified that need to be explored in future researches. First, how teachers teach the topic in the classroom needs to be further documented and explored in future research. Second, the climate change knowledge test may be improved in terms of internal consistency. Item analysis may likewise be performed to make sure that each item is able to effectively discriminate achievers from low performers. Third, lesson study on climate change may be conducted to document how students learn from the lesson and to identify the difficulties they have encountered. Fourth, the use of inquiry-based approaches in teaching climate change may be explored in future studies. Lastly, conducting a similar study in more areas in the archipelago is encouraged to accurately paint the status of climate change education in the Philippines.

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Appendix A

Basic Questionnaire

Please check (✓) the item that corresponds to your answer.

Type of School: _____ Public _____Private

Gender: _____ Male _____Female

Household size (yourself + other people living with you in your house)
(Please select one.)

_____2 _____3 _____4 _____5 _____6 _____7 _____8 or more

Household income (Average annual income of all people whom you live with)
(Please select one.)

_____under Php 40,000

_____Php 40,000 - Php 59, 999

_____Php 60, 000 - Php 99, 999

_____Php 100,000 - Php 249, 999

_____Php 250,000 and above

Parents' Highest Educational Attainment *(Please select one.)*:

_____Elementary undergraduate*

_____Elementary graduate

_____High school undergraduate

_____High school graduate

_____Post secondary undergraduate

_____Post secondary graduate

_____College undergraduate

_____College graduate

_____With Master's degree units+

_____With Master's degree

_____With doctorate degree units

_____With Doctorate degree

Was climate change discussed in any of your classes before?

____Yes ____No

Have you attended or participated in any of the following activities in the past?

____a lecture on climate change

____an exhibit on climate change

____listened to a TV program on climate change

____read a book about climate change

*****_Undergraduate_ means parent has been in that level of education but was not able to graduate

[+]_With units_ means that a parent has taken a Master's or Doctorate degree but was not able to graduate.

Appendix B

Climate Change Knowledge Test

Please answer the questions below to the best of your ability. To answer, put a ✓ on the corresponding space before the option.

Questions	Options
1. What is global warming?	____Caused mostly by human activities ____Caused by both human activities and natural changes ____Caused mostly by natural changes in the environment ____None of the above because global warming isn't happening Others, please specify: _____.
2. The "greenhouse effect" refers to:	____The Earth's protective ozone layer ____Gases in the atmosphere that trap heat ____Pollution that causes acid rain ____How plants grow ____Don't know
3. Which of the following does NOT affect the average global temperature of the Earth?	____Greenhouse gases in the atmosphere ____Changes in the Earth's orbit around the sun ____Volcanic eruptions ____The amount of dust in the atmosphere ____Sunspots ____Clouds ____Earthquakes ____Whether the Earth's surface is light or dark colored ____The phases of the moon

4. Which of the following gases in the atmosphere are good at trapping heat from the Earth's surface?	____Carbon dioxide ____Methane ____Water vapor ____Hydrogen ____Oxygen ____Carbon monoxide ____Don't know
5. Which of the following are "fossil fuels"?	____Solar energy ____Natural gas ____Wood ____Coal ____Oil ____Hydrogen
6. What gas is produced by the burning of fossil fuels?	____Oxygen ____Helium ____Hydrogen ____Carbon dioxide ____Don't know
7. To the best of your knowledge, roughly how much carbon dioxide was in the atmosphere in the year 1850?	____150 parts per million ____290 parts per million ____350 parts per million ____390 parts per million ____450 parts per million ____Don't know

8. Roughly how much carbon dioxide is in the atmosphere today?	____150 parts per million ____290 parts per million ____350 parts per million ____390 parts per million ____450 parts per million ____Don't know
9. How will you describe the amount of carbon dioxide in the atmosphere has changed over the past 500 years	____No change ____Linear increase ____Linear decrease ____Exponential increase ____Exponential decrease
10. If we were to stop burning fossil fuels today, the amount of carbon dioxide in the atmosphere would decrease almost immediately.	____True ____False
11. If we were to stop burning fossil fuels today, global warming would stop almost immediately.	____True ____False
12. Of the following, which one do you think contributes most to global warming?	____Cars and trucks ____The hole in the ozone layer ____Deforestation ____Toxic wastes ____The sun ____Burning fossil fuels for heat and electricity ____Nuclear power plants ____Volcanic eruptions

	____Cows ____Aerosol spray cans ____The space program ____Acid rain
13. The Earth's climate has changed naturally in the past, therefore humans are not the cause of global warming.	____True ____False
14. Global warming will cause temperatures to increase by roughly the same amount in all countries.	____True ____False
15. Any recent global warming is caused by the sun	____True ____False
16. Which of the following causes coral bleaching?	____Warmer ocean temperatures ____Chemical spills in the ocean ____Acid rain ____Overfishing
17. Which of the following statements is correct?	____All of the glaciers on Earth are melting away ____Most of the glaciers on Earth are melting away ____Some of the glaciers on Earth are melting away ____None of the glaciers on Earth are melting away ____Don't know
18. Over the past 100 years, has the speed of glacier melting increased, decreased, or stayed the same?	____Increased ____Stayed the same ____Decreased

19. If no additional actions are taken to reduce global warming, how much do you think global sea levels will rise by the year 2100?	____10-12 feet ____3-4 feet ____6-9 inches ____Zero ____Don't know
20. Which of the following causes ocean acidification?	____Absorption of carbon dioxide by the ocean ____Chemical spills in the ocean ____Acid rain ____Warmer ocean temperatures