

Students' Climate Change Literacy: Implication for Climate Change Education in Public Secondary Schools in Kabacan, North Cotabato

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Abstract— This study investigated the climate change literacy of 219 Grade 10 students in public secondary schools in Kabacan, North Cotabato. This research utilized an adapted questionnaire which measures the cognitive, affective and behavioral engagement on climate change. The cognitive domain used a 5-point scale which allowed the researcher to assess the students' level of certainty in their knowledge. Results revealed that students have reasonable knowledge but most of the statements were answered with low level of certainty on the basic concept, causes, effects and mitigation. Moreover, most students lack thorough knowledge on the causes of climate change. Also, several misconceptions on the essential principles were revealed (e.g. El Niño as part of climate change; greenhouse gases as air pollutants; greenhouse effect as an environmental problem; attribution of climate change to ozone hole; confusion on the definition of weather and climate and etc.). The respondents agreed that climate change influences them in many ways and showed concern on its severe effects. However, considerable number of students negatively viewed climate change that people's action is too late to alleviate the problem. Significant difference was also found on their cognitive engagement when they are grouped according to gender.

Keywords—Climate Change Literacy, Education, Misconceptions, Skepticism.

I. INTRODUCTION

CLIMATE change is the leading inter-generational problem fronting mankind at the present time. The scientific community now recognizes, with a very high level of confidence, that recent industrial and agricultural activities are having a profound impact on earth's climate^[1]. This is a realistic scenario for the near future and it concerns today's children. In recent studies, it is discouraging to find out that students lack knowledge and understanding about climate change^{[2] [3] [4] [5] [6]}. Being knowledgeable about climate change is crucial in order to create wise and effective solutions to prevent its inevitable effects. Truly, without climate education, climate disruption is unavoidable^[7].

A. Objectives

The general objective of this study was to determine the climate change literacy of Grade 10 students of Kabacan National High School and University Laboratory School.

Specifically, the study sought to:

1. determine the socio-demographic profile of the respondents;
2. determine the students' knowledge on the basic concepts, causes, effects, and mitigations of climate change;
3. determine the students' affective engagement on climate change;
4. determine the students' behavioral engagement on climate change; and
5. determine if there is a significant difference on the engagement of students when grouped according to gender..

II. METHODOLOGY

This study used adapted survey questionnaire^{[8] [9]}. The survey was used to determine the knowledge, affective and behavioral engagement of the students. Overall, it is composed of 55 statements. The first 35 statements test the knowledge of the respondents. There is a definite correct answer to each question. Respondents indicate whether they know the statement is *definitely true*, *think it is true*, *don't know* (whether it is true or false), *think it is false* or *definitely false*. This 5-point scale enhances the survey results by allowing the researcher to assess the young people's level of certainty^[10]. Ten statements were arranged to assess the affective engagement of the students. The survey-questionnaire was based on the 4-point scale responses, to wit: 1. Strongly Agree (SA), 2. Agree (A), 3. Disagree (D), and 4. Strongly Disagree (SD). Another 10 statements were prepared to test the behavioural engagement of the students. The survey-questionnaire was based on the 4-point scale responses, to wit: 1.Never, 2.Rarely, 3.Often, and 4.Always. The respondents were asked to check (✓) only one (1) option.

In determining the number of respondents, the researcher used the Slovin's formula with a 5% margin of error. As a whole, the Grade 10 students of Kabacan National High School had a population of 366 while the University Laboratory School had 120. By means of the formula mentioned, the computed number of respondents is 219: 165 from Kabacan National High School and 54 from the University Laboratory School. In selecting the respondents, the researcher used simple random sampling through draw-lots method.

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The data of the study were tabulated and interpreted using frequency counts, mode, percentages, weighted mean, and t-test analysis. To determine the level of students' knowledge on basic concepts, causes, effects and mitigation, score range was used (below 20% is low; 40%-59% is average; 60%-79%) is high and 80% above is very high).

III. RESULTS AND DISCUSSION

3.1 Profile of the Respondents

Table 1 shows that majority of the respondents were females (61.20%) and (51.60%) of them lived in barrios. Most probably, the respondents chose to study in Poblacion because schools in this area are more equipped with facilities that will provide better learnings.

TABLE I
CHARACTERISTICS OF THE GRADE 10 RESPONDENTS. ULS AND KNHS.
SY 2016-2017.

CHARACTERISTICS		FREQUENCY (N = 219)	PERCENT
SEX	Female	134	61.2
	Male	85	38.8
LOCATION	Poblacion	106	48.4
	Barrio	113	51.6

3.2 Knowledge on the Basic Concepts

Table 2 indicates that generally, the respondents had "average" knowledge on the basic concepts of climate change. Some foreign and local studies agreed with this finding demonstrating that majority of the high school students surveyed whose age ranges from 12-16 were moderately intellectual on the basic concepts of climate change^{[9][11][12]}.

TABLE II
KNOWLEDGE OF GRADE 10 STUDENTS ON CLIMATE CHANGE. ULS AND KNHS. SY 2016-2017.

KNOWLEDGE LEVEL	Basic Concepts		Causes		Effects		Mitigation	
	f (N=219)	%	f (N=219)	%	f (N=219)	%	f (N=219)	%
Very Low (below 20%)	2	0.9	18	8.2	4	1.8	8	3.7
Low (20% - 39%)	42	19.2	82	37.4	30	13.7	29	13.2
Average (40%-59%)	155	70.8	105	47.9	41	18.7	49	22.4
High (60%-79%)	20	0.0	13	5.9	120	54.8	66	30.1
Very High (80% above)	0		1	0.5	24	11.0	67	30.6
Mean	8.04	44.7%	1.71	28.5%	3.95	56.4%	2.71	67.8%
Standard Deviation	1.94		1.67		1.40		1.15	

In figure 1, though many students correctly identified some of the basic concepts, a low level of certainty was detected. This implies that most of the respondents are skeptical in their knowledge pertaining to the essential principles of climate science. In a more detailed sense, as shown in Figure 1, S2, S4, S5, and S9 which relate to sun as the main source of energy for the earth's climate system, carbon dioxide reduction in the atmosphere through plants and trees, global warming as a threat to the survival of some animals, and scientists and economists prediction on the positive and negative impacts of global climate change, were all answered reasonably well (69%-85%). Probably, the respondents have meaningful learning experience during the past years because these topics are widely integrated in their elementary subjects. In some studies, secondary students specifically stated that hotter weather would result in more plant and animal deaths^{[3][9]}. This was confirmed by the Intergovernmental Panel on Climate Change (2007), asserting that if global average temperature will be intensified, about 20-30% of flora and fauna species are likely to be at risk of extinction. Just 16, 29, 18 and 25 incorrect responses were given. It is clear that the students hold satisfactory knowledge on these statements. They are knowledgeable about the hazard of global warming on the plants and animals.

S1, S6, S12, S13 and S18 which speak about the proximity of the sun to earth, the usage of natural records to

learn about past climates, water vapor as a greenhouse gas, existence of greenhouse gases for million years as contributory factor to the creation of life and greenhouse effect as caused by naturally occurring gases in the atmosphere, were all answered fairly (62%-85%). However, the students' level of uncertainty was quite high. Only 39%, 22%, 33%, 28%, and 27% were sure that the preceding statements are true respectively. These topics are present in Science Learner's and Teachers' Material-Grade 9 (2013) but it is noticeable that students are not quite sure about their knowledge. Though many of the students correctly identified the principle in Statement 1, a large proportion of the respondents (57%) incorrectly knew that man is the only force or cause of climate change (S7). Climate varies over space and time through both natural and man-made processes and climate change occur in response to changes in some aspect of earth's environment. These include regular changes in earth's orbit about the sun, re-arrangement of continents through plate tectonic motions, or anthropogenic modification of the atmosphere^[16]. However, 24% correctly identified that the statement is false and 19% said they "don't know".

When asked if "Global warming can quickly and easily be stopped" (S17) and "Scientific observations indicate that global climate has never changed in the past and will remain constant in the future" (S3), less than half of the percentage of the students (31-47%) correctly identified the statement. Upon reviewing the latest K-12 module for Science 9, the prescribed reference for teachers and learners, this idea was

not incorporated in the readings. Still, significant number of students (35-40%) erroneously determine that it can be easily stopped. This is an indication of students' knowledge and awareness insufficiency on the historical background as well as the future trends of climate [5]. Scientific observations indicate that global climate has been constantly changing in the past, present, and in the future [17].

On the other hand, S8, S10, 11, S13, 14 tested respondents' knowledge on the El Niño Southern Oscillation, definition of weather and climate, the energy responsible for greenhouse effect, composition of greenhouse gases, and attribution of ozone hole to greenhouse effect. More than half (73%-78%) of the students incorrectly answered "definitely true" that it is the case [2] [3] [5] [8] [11]. El Niño is one of the seasonal variations and multi-year cycles of climate that produces warm, cool, wet, or dry periods across different regions and is a natural part of climate variability. They do not represent climate change [17]. Though this was given great emphasis in the K-12 Science Teacher's and Learner's Guide

for Grade 9 (pg. 56-57) [18], it seems that the students' misconception is still, at a high degree level. Students were confused about the type and source of radiation involved in the greenhouse effect. Moreover, students are incapable to differentiate climate and weather [5][11]. This indicates that up to now, the students have confusion on the definition of weather and climate. It appeared that most of the students have trouble understanding these and worst, having no idea at all. The possible reason is that climate change concepts found in science textbooks have been contributing to students' misconceptions about climate change [3]. On the other hand, 15%-23% answered "don't know", 3-8% were right by thinking it is false, and only 3-15% know that it is "definitely false". Because of highlighting the harmful effects of climate change frequently, the beneficial role of greenhouse gases in supporting life in the planet is often less known. Hence in Statement 15, it is quite disappointing that most of the students (78%) incorrectly identified that "greenhouse effect is an environmental problem".

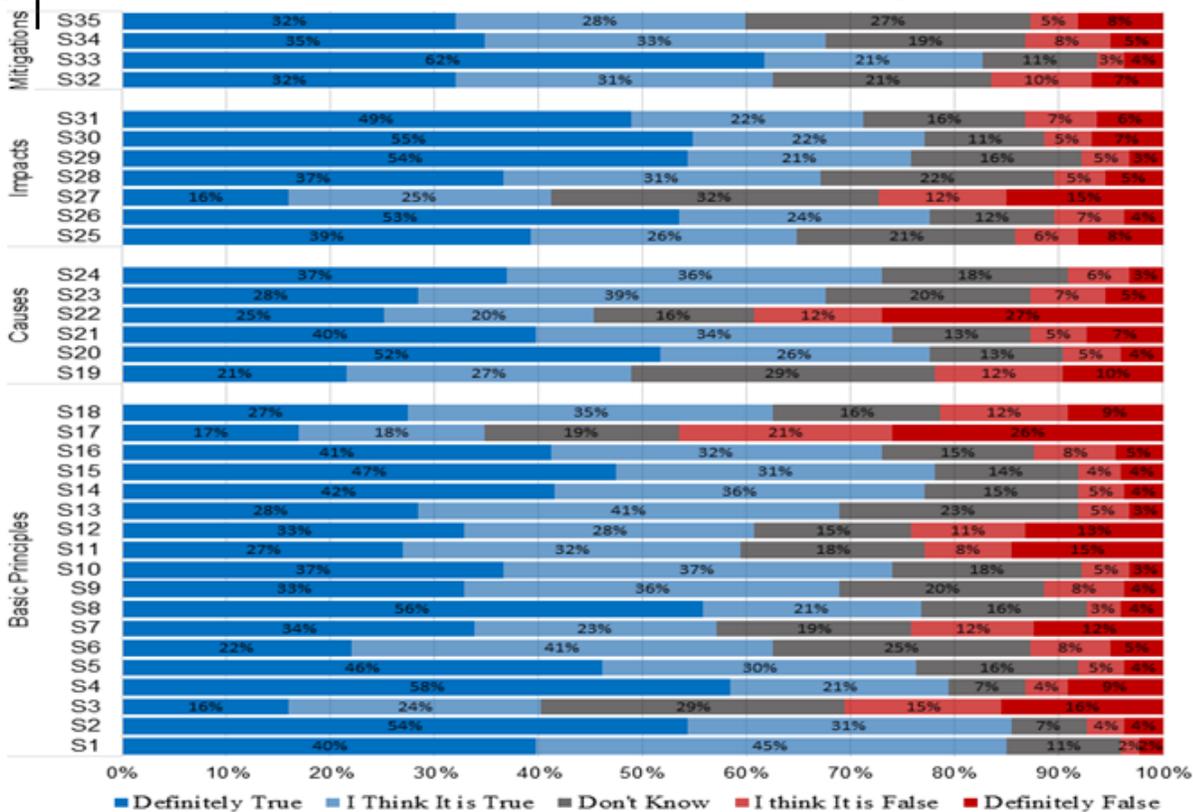


Fig. 1 Knowledge of Grade 10 Students on Climate Change. ULS and KNHS. SY 2016-2017

3.3 Knowledge on the Causes of Climate Change

As indicated in table 2, majority of the respondents (28.50%) have "low" knowledge on the causes of climate change. This is parallel to the study of [4]. The potential reason for this is the teacher related factor wherein Science teachers who have taught more than 5 years or an average 14 years is no guarantee of good knowledge on climate change causes [7]. Since individuals have pint-sized knowledge about the causes of climate change, it would be difficult to make

responsible decisions and efficient solutions to decrease the impacts of climate change [2].

Specifically, figure 1 shows students' knowledge on the causes of climate change. Most of the statements were answered incorrectly. It also shows that students have strong uncertainty and misconception on this area. This indicates poor knowledge of students which is reflected to the performance of the teachers who facilitates learning inside the classroom. According to Wolf and Moser (2011), knowledge of the causes of anthropogenic climate change is generally considered useful as it lays an initial foundation for

directing people to the right kinds of mitigated actions. In statement 20, most of the respondents (78%) were correct that burning coal, oil and gas contributes to global warming by increasing the amount of greenhouse gas in the air. Similarly, Mower's (2012) findings exposed that high school students held satisfactory knowledge on this areas.

On the other hand, 13% held no knowledge about it and only 9% gave the wrong answer. As regards statement 19, 21, 23, 24, 48%-74% of the respondents erroneously answered the following statements: natural gas does not contribute to aggravating the greenhouse effect^[4]; the use of artificial fertilizers increases the concentration of CO₂ in the atmosphere; methane is the largest source of human greenhouse gas emissions; and that ozone holes let more solar energy to get into the earth causing global warming^{[2] [3] [11]}. It is interesting that this misconception not only persists but actually increases as the educational level progresses^[4].

3.4 Knowledge on the Effects of Climate Change

As shown in table 2, in general, the findings reflected that the level of students' knowledge on the effects of climate change is "average". Overall, the students seemed to be familiar with impacts of climate change^{[4] [11]}. However, in figure 1, it is noticeable that many students are still uncertain about the effects of climate change. This indicates that they are skeptical with their present knowledge and that the climate change education in these schools is deficient. In figure 1, statements 25, 26, 28, 29, and 30 were all answered reasonably well (65%-77%) which inquire particularly on rising of sea levels, consequences of climate on farming^{[13] [14]}; adaptation or extinction of species on climate change^{[3] [4] [11]}; effect of climate change on developed countries^[13]; and worsened flooding everywhere^{[8] [11] [13]}. Only minimal number of students (8%-14%) incorrectly responded to it. On the other hand, many of the students (41%-71%) incorrectly identified that the ice cover of Earth's two Polar Regions has increased during the past years (S27) and that "global warming can cause skin cancer" (S31). Merely, 13%-27% correctly identified this as a fallacy.

3.5 Knowledge on the Mitigations of Climate Change

Table 2 presents the students' knowledge level on mitigation of climate change. The results shows an overall mean of 2.71 and a standard deviation of 1.15 which is "high". This indicates that the respondents demonstrate sound understanding on this topic. Nevertheless, figure 1 shows that many students are still uncertain about their knowledge on climate mitigation. 'Skepticism' in public attitudes towards climate change is also seen as a significant barrier to public engagement^[19].

This implies that most of the respondents are not sure of the actions to take to alleviate the impacts of climate change. The result in statement 33 shows that most of the students (83%) held considerably high knowledge regarding reforestation as an effective prevention for global climate change. This implies that students have a remarkable knowledge that planting trees can reduce global warming^{[1] [8]}. Still, there were 11% who said they "don't know" whether it helps or not. Only 7% answered it incorrectly. Similarly, statements 32, 34, and 35 were answered noticeably well (60%-68%) which tackle on minimal usage of electricity; renewable energy sources^{[4] [8] [11] [15]}; and utilization of public transport as ways to mitigate climate change^[3]. Just slight number of the respondents (13%-17%) responded erroneously. Generally, the students' knowledge on the mitigation of climate change is remarkably high. This is necessary to deal with the inevitable impacts of climate change due to past emanations^[13]

3.6 Students' Affective Engagement on Climate Change

As shown in table 3, most of the respondents were convinced that global warming is happening. They agreed that they are really worried about the effects of climate change in the world and believed that the primary cause of this is the human activities. Though the respondents held belief that they can do many things to contribute in climate change mitigation, respondents negatively responded that "the problem of climate change is too serious and our actions are already too late". In a study, it was found out that being told the potential negative impacts of climate change does not inspire them to act^[8]. Despite of their negative view on climate change, many claimed that it is their desire to make changes in their life to reduce the impacts of climate change. This implicates that the respondents are aware that they too can engage to minimize the anthropogenic CO₂ emissions^[5]. The result also showed that the respondents are very attentive about climate change news.

Moreover, most of the students considered themselves as knowledgeable individuals when it comes to climate change and disagreed that they would only do a bit to reduce it if everyone else did as well. Correspondingly, respondents agreed that people should be made to reduce their energy consumption if it reduces climate change. This implies that they have the willingness to help mitigate the impacts of climate change, independently.

The overall mean is 2.74 which is equivalent to "agree". This denotes that in general, the respondents are moderately and affectively engage on climate change. This average level of concern could stem from the average understanding of the impacts, as demonstrated in this research.

TABLE III
AFFECTIVE ENGAGEMENT OF GRADE 10 STUDENTS ON CLIMATE CHANGE. ULS AND KNHS. SY 2016-2017.

STATEMENT	WEIGHTED MEAN	DESCRIPTION
1. Really worried about the effects of climate change in the world.	3.02	Agree
2. Always pay special attention to climate change news.	2.76	Agree
3. Would only do a bit to reduce climate change if everyone else did as well.	2.48	Disagree
4. Believe that human activities are the primary cause of climate change problem.	2.93	Agree
5. The problem of climate change is too serious and our actions are already too late.	2.68	Agree
6. Believe that he/she myself can do many things to contribute to the improvement of climate change problem.	2.91	Agree
7. People should be made to reduce their energy consumption if it reduces climate change.	2.72	Agree
8. Want to make changes in my life to reduce climate change.	2.79	Agree
9. Convinced that global warming is happening.	2.83	Agree
10. Believe that I know a lot about climate change.	2.58	Agree
Overall Mean*	2.74	Agree

*Computed with reversed scoring for negative statements.

Legend:	Scale	Description	Weighted Mean Range	Scale	Description	Weighted Mean Range
	1	Strongly Disagree	1.00 – 1.49	3	Agree	2.50 – 3.49
	2	Disagree	1.50 – 2.49	4	Strongly Agree	3.50 – 4.00

3.7 Students' Behavioral Engagement on Climate Change

Table 4 displays the students' behavioral engagement on climate change. Majority of the respondents were often engaged in all the given statements which indicate that the students are moderately engaged in taking action on the impacts of climate change. The result indicates that most of the respondents often turn off the lights when leaving the room. In the questionnaire, this is the highest scored question which means that respondents are more often involved to this practice. Students also often engaged on the following behaviors: close refrigerator door while deciding; turn off computer when done with it; use both sides of paper when drawing or writing; persuade family members to recycle; ask people not to use water and electricity if not necessary and separate waste materials for recycling^{[5] [12]}. This implies that students have the tendency to recycle and persuade others to recycle which are good conservation behaviors^[12].

Overall, respondents were often active in their behavioral engagement on climate change. Still, there is an observable impeding force for not taking action against climate change. Respondents who feel informed about climate change take much more action to combat climate change than those who feel poorly informed^[7]. Young people are not only capable of educating other people but can also be an agent of action for behavioral change towards climate change in their community^[20].

TABLE IV
BEHAVIORAL ENGAGEMENT OF GRADE 10 STUDENTS ON CLIMATE CHANGE. ULS AND KNHS. SY 2016-2017.

STATEMENT	WEIGHTED MEAN	DESCRIPTION
1. Walk to go short distances.	2.67	Often
2. Turn off computer when done with it	3.11	Often
3. Turn off the lights when leaving the room	3.22	Often
4. Separate waste materials for recycling	3.12	Often
5. Persuade family members to recycle	2.89	Often
6. Close refrigerator door while deciding	3.15	Often
7. Use both sides of paper when drawing or writing	2.91	Often
8. Take public transportations, or ride bike instead of using personal car	2.84	Often
9. Ask people not to use water and electricity if not necessary	2.79	Often
10. Donate items like clothes and shoes to people and institutions in need	2.76	Often
Overall Mean	2.95	Often

Legend:	Scale	Description	Weighted Mean Range	Scale	Description	Weighted Mean Range
	1	Strongly Disagree	1.00 – 1.49	3	Agree	2.50 – 3.49
	2	Disagree	1.50 – 2.49	4	Strongly Agree	3.50 – 4.00

3.8 Test of Difference When Grouped According to Gender

Table 5 reveals the cognitive engagement of the respondents when grouped according to gender. Results reveal that the t value of 2.38 and p value of 0.02 is significant at 5% level. It was found that females are more knowledgeable than males. This implies that female hold greater information about climate change compared to males.

This is similar with the findings of CEED (2011) that girls have higher level of understanding and awareness regarding global climate change. On the other hand, the affective and behavioral engagements of students are not significant at 5% level.

TABLE V
TEST OF DIFFERENCE IN THE AFFECTIVE, BEHAVIORAL AND COGNITIVE ENGAGEMENT OF STUDENTS
WHEN GROUPED ACCORDING TO GENDER.

ENGAGEMENT	SEX	n	MEAN	sd	t value	df	p value
Cognitive	Male	85	15.72	3.88	2.38*	216	0.02
	Female	133	16.88	3.26			
Affective	Male	85	2.72	0.51	0.37 ^{ns}	216	0.71
	Female	133	2.75	0.58			
Behavioral	Male	85	2.87	0.68	1.26 ^{ns}	216	0.21
	Female	133	2.99	0.67			

ns – not significant at 0.05 level * – significant at 0.05 level

IV. CONCLUSION

From the findings of the study, the following are the conclusions: Majority of the respondents were female and lived in barrio. The students' knowledge on the basic concepts of climate change was average. Nevertheless, students have some misconceptions on the essential issues.

Though most of the statements were correctly responded, many of the items were answered with high level of uncertainty on the basic concept, causes, effects and mitigation of climate change. Furthermore, students' knowledge on the causes was low. Thus, schools currently do not do enough to educate their students about the different ways in which they can affect the climate. Education unquestionably plays a pivotal role in helping young people to respond to climate change.

In spite of this, the effects and mitigation are well understood. The respondents are likely to take action in climate change mitigation just because of their knowledge on the severe effects of climate change. Still, effective mitigation and adaptation are impossible if the students were poorly knowledgeable on the origins of climate change. The respondents were often engage in terms of the affective and behavioral domain. Most of the respondents were worried on the effects of climate change and were willing to mitigate it. Still, some of the respondents had negative view on climate change. It was also revealed that respondents are often engaged on everyday activities that aid the reduction of atmospheric carbon dioxide. Therefore, it was concluded that students tend to be concerned on the future impacts of climate change and indicated a verbal commitment as well a sense of responsibility to alleviate this problem. Females were more knowledgeable than males when it comes to the cognitive aspect of climate change.

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