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Students' Conceptual Understanding and Images on Climate Change

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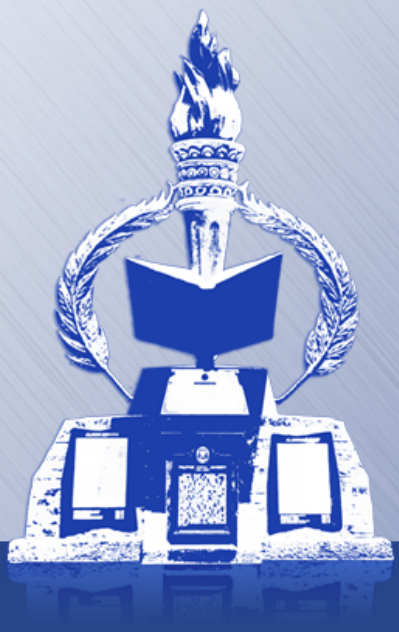

STUDENTS' CONCEPTUAL UNDERSTANDING AND IMAGES ON CLIMATE CHANGE

A Thesis Presented to
The Faculty of College of Graduate Studies and Teacher Education Research
Philippine Normal University
Taft Avenue, Manila

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts in Science Education
with Specialization in General Science

Rosyl C. Salinas
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APPROVAL SHEET

This thesis entitled **"STUDENTS' CONCEPTUAL UNDERSTANDING AND IMAGES ON CLIMATE CHANGE"** prepared and submitted by **ROSYL C. SALINAS** in partial fulfillment of the requirements for the degree of Master of Arts in Science Education with specialization in General Science, is hereby recommended for approval and acceptance.

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ABSTRACT

Name:	Rosyl C. Salinas
Title:	Students' Conceptual Understanding and Images on the Concept of Climate Change
Key Concepts:	climate change, students' conceptual understanding, students' images
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The issue of climate change has a real impact in the Philippines and the manifestation of its effects are the changes in rainfall patterns, increase the number of tropical cyclones and occurrence of extreme weather condition. Thus, the study aimed to determine the students' conceptual understanding and images on these concepts a) temperature b) rainfall c) cyclones d) drought e) extreme meteorological condition and e) greenhouse gases. In order to come up with the objective of the study, the researcher developed the Explain and Illustrate Task Instrument (EITI) with a corresponding scoring rubrics that were validated by experts with 4.53 as totally acceptable and 4.28 as a highly acceptable content and face validity means, respectively.

Moreover, a descriptive correlation design was utilized in this study. Survey method was employed in administering the EITI to two hundred twenty four (224) Grade Ten (10) students from three public high schools in Metro Manila. Furthermore, the students' responses were analyzed and tallied to illustrate the results of students' conceptual understanding and images.

Also, the existing significant relationship between students' images and conceptual understanding on the causes and effects of the different climate change concepts. As a result, the

students have a partial understanding on the causes of increase of temperature while the rest of the concepts on rainfall, cyclone, drought, extreme meteorological condition and greenhouse gases demonstrate no understanding. On the other hand, students demonstrate specific misconception on the effects on the concepts of rainfall, cyclone and drought while students have no understanding on the concepts of temperature, extreme meteorological condition and greenhouse gases. The results also reveal that the students' images demonstrate depiction, which means the students generate a representation based on the physical attribute on the different concepts on climate change. Furthermore, the researcher also found out that there are existing strong significant relationships between students' conceptual understanding on the causes and effects and images on the concepts of cyclone, extreme meteorological condition and greenhouse gases. Thus, strong significant relationship means, the students can explain and illustrate the concept or cannot both explain and illustrate the concept. Based on the result, the students cannot both explain and illustrate the concepts of cyclone, extreme meteorological condition and greenhouse gases. On the other hand, there are also very weak significant relationships between students' conceptual understanding on the causes and images on the concepts of temperature, rainfall and drought, which means that the students can be able to explain the concept but cannot illustrate the concept or vice versa.

For the recommendation of this study, the researcher is suggesting to use another group of independent respondents to verify the veracity of the results to other demographic variables such as age, sex, socio-economic status and year level of the present study on conceptual understanding and images on climate change. Moreover, to come up with an EITI version using a vernacular translation for the future respondents to have an easy understanding of the context of the task and conducting interviews on selected respondents to further triangulate their

responses and illustrations on the EITI. Also, to cover other related concepts of climate change which are not included in the study and to seek expert's evaluation on the responses of students' concerning the assessment of their conceptual understanding and images on the different concepts of climate change.

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THE PROBLEM AND ITS BACKGROUND

Introduction

The Philippines is now facing the real impacts of climate change and there are changes in rainfall, intensity of tropical cyclones, temperature and frequency of extreme weather events which were projected by Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) (Servando, 2011). In addition, Philippines has one of the longest coastlines in the world and due to its geographical location it will not be safe from the adverse effects of climate events that are anticipated to happen in the world (Capili, 2005). According to the Global Climate Risk Index of 2015, the Philippines was described to be one of the most affected areas of climate change. More specifically, the country ranked fourth which suffered the most extreme weather events such as flooding and storms over the past 20 years (Kreft, et al., 2015).

The manifestation of changing climate is that, there is more number of hot days and warm nights, but the decrease of cold days and cool nights in most part of the country indicate the trends of extreme daily temperatures. Furthermore, daily rainfall is found to be more intense and more frequent and in terms of extreme events like Typhoon Yolanda in 2013 was the most likely to be remembered. The home and school of the students who are living in the urban areas are one of the most affected by intense downpours and flood. For the students it is essential to understand what is causing climate change and knowing who is the most vulnerable to the impacts of climate change and what we can do to prepare. Moreover, according to

Intergovernmental Panel on Climate Change's (IPPC) (2014), as cited by Pitpitunge, et al., 2015) that lack of knowledge about climate change endangered vulnerable people specifically future generations especially on the natural and human system, despite there are information, guidelines and warning systems designed by concerned agencies to inform the public, just like what PAGASA and other related agencies has been doing in the Philippine setting.

On the other hand, according to Wong (2007) the importance of distinguishing the relationship between concepts and procedures will develop and improve students' conceptual understanding in the context of the principles of learning mathematics, which may be also be applicable in learning different science concepts, specifically in climate change. The term conceptual knowledge is also known as conceptual understanding as the existing understanding of students will give interpretation on the understanding and incorporation of new information. When the students exhibit errors, it will provide opportunities for teachers to adapt to their lessons to address such errors and to guide students towards improved understanding (Wong, et al., 2007; Rittle-Johnson, Siegler, and Alibali, 2001; Anderson, 2000). The greatest challenge for teachers is teaching conceptual understanding which is the primary goal in science education according to Moran and Keeley (2015). They also added that the students manifest conceptual understanding on the concept if they can do the following: (a) think with it (b) use it in areas other than that in which learned it, (c) state in their own words, (d) find a metaphor or an analogy, for it, or (e) build a mental or physical model of it. Moreover, the conceptual understanding of students permits one to transfer and explanation of a phenomenon to different variants of a situation that have been previously analyzed (Viennot, 2001). It was also mentioned by Panprueksa (2012) the students' conceptual understanding is important in order to achieve successful learning and teaching. Saleh (2011) that was also cited by Lalla, et al., (2014) that

most educators agree that science and learning should move away from a system that promotes science primarily as recall or factual information and rote computation to one which emphasizes conceptual understanding and logical process skills.

Furthermore, it is also necessary to comprehend students' representation or images since it reveals their explanations, translations, and mental understanding of their learning (Wu, et al., 2001; Kozma and Russell, 1997). More specifically, Perkins, et al., (1995) considered the chemical representations as visual display of students' conceptual constructs. In addition, Zirbel (2005) described that the representation of concepts generally in a form of image may suggest students' understanding of a science concept. She further explained that the profound understanding of a certain concept involve the ability to remember many connected concepts and containing deeper meaning in a single image. Zirbel (2005) further suggested that it is necessary to have a substantial conceptual knowledge and visual-spatial abilities to determine the performance of understanding and representational skills of students. In addition, the use of image in the field of science was used as the formation of internal representation from an external representation which will be the tool for conceptual understanding of the students according to Gilbert, et al., 2008 and was also cited by Evagorou, et al., 2015. Furthermore, to learn science effectively, the students must understand the different representations of science concepts and processes, to be able to translate a representation into one another and understand their coordinated use in representing scientific knowledge (Sutopo, 2011; Hubber, et al., 2010). Also, there is an advantage of having a concrete representation for students to easily understand abstractions (Olson, 2008; Lawson, 2002).

It is also important that the teachers need to determine the students' conceptual understanding and images on the different concepts of climate change thus; Cordero (2008)

explained the significance of recognizing students' presumptions or previous knowledge on certain topics. He discussed that students go to school with ideas on the different topics including their interpretation on how they view the world around them. This observation is the same as to the idea of Zirbel (2005) when he explained that students do not enter the classroom as a "blank slate," which is further described by the theory of Constructivism, where students used their prior knowledge or schema in constructing their new understanding. With the aforementioned discussion, it is necessary for science teachers to assess students' schema, which may serve as the baseline of their conceptual understanding as well as of their representation on the different concepts of science, more specifically on climate change. Shepardson (2011) stated that to understand the concepts on climate change they must first understand climate as "a system and how changes to this system due to both natural and human influences result in climatic and environmental changes and feedback." Likewise, Mcconnell et al., (2010); O'Neill and Hulme, (2009) emphasized that teachers may use images to which students can relate in order to help students to have better understanding on the impacts of climate change. Some students are likely to respond to depictions of the impacts of climate change on local areas to which they are emotionally connected. In addition, there is a dearth on studies that show any evidence of the impact of the climate change course on student learning and their environmental behavior (Nam, 2011), thus the Department of Education (DepEd) in the Philippines recommends that issues on climate change shall be included in the basic education curriculum to better educate not only the students but also the public. In response to the said need, The Disaster Readiness and Risk Reduction course in the senior high school program of the K to 12 contains concepts of climate change and adaptation and mitigation procedures, but some of the basic concepts of climate change were already discussed in the Grades 7 to 10 science subjects. In addition, due to the

experience of students it created a gap between the shared experience and understanding of students between everyday and scientific explanations of scientific principles according to Furberg (2016). Thus, it is necessary to assess the baseline understanding of students on climate change that they have learned from the junior high school, which served as their schema for their further learning, thus the researcher opted to develop the Explain-Illustrate Task Instrument (EITI) to determine the students' conceptual understanding and images on the different concepts of climate change.

Conceptual Framework

The issues on climate change concept is not a local but is a global problem especially in the Philippines that the real impact on the causes and effects of climate change has threaten vulnerable countries according to Servando (2011) of PAGASA. Furthermore, climate change is given priority by the international development especially its effect but slightly felt in developing countries. A report of UNESCO (2012) mentioned that warmer countries like the Philippines are likely prone to rainfall variability.

Moreover, there are several attempts to introduce climate change topic in science education. Thus, the conceptual understanding of students will provide teachers opportunities to enhance their lessons and address common misconceptions (Wong, et al. 2007; Rittle-Johnson, Siegler, and Alibali, 2001; Anderson, 2000). On the other hand, it is also important to understand students' representation or images on certain science concepts because it gives explanations, translations, and mental understanding of their learning experiences (Zirbel, 2005; Wu et al., 2001; Kozma and Russell, 1997).

Furthermore, students' written words and drawings are described as conceptual visualizations or representations of their understandings which contain number of concepts with corresponding embedded meaning, thus students' conceptions may be constructed from their graphic representations (Alerby, 2000; Kress et al., 2001 and Vosniadou & Brewer, 1992 as cited by Shepardson, et al., 2012). There are recent findings that a certain visual or mental imagery can provoke counter-productive responses and so it is important to understand how student construct and represent the concepts on climate change (Moloney, et al., 2014; Cole, 2005). With the above-mentioned issues on climate change and studies on students' conceptual understanding and representation, this present study aimed to describe the students' conceptual understanding and images on the different concepts in climate change. It is assumed that students' conceptual understanding on both causes and effects of the different concepts on climate change have direct influence on students' images on the said concepts, or the other way around. Thus, this study also determines the significant relationship that may exist between students' conceptions on the causes, effects and images of the different concepts on climate change.

In this study, the researcher stressed the importance of determining the students' conceptual understanding on the different concepts of climate change because global understanding is the ability to identify the cause-effect patterns over long distances, considering the Earth ecosystem as a whole and perceive how climate change is affecting the entire global (NASA, 2012 as cited by Korsager, 2013). Thus, Korsager (2013) mentioned that the students can explain mutually causal connections, which are complex causalities made up of multiple linear patterns including both indirect effects, and cascading patterns, in which causes can be seen as effects as causes. Also, there is a growing recognition that students need to learn how to interpret and construct representations of scientific concepts. Furthermore, it is possible that

students show understanding of a particular concept with a representation or image before they have had an opportunity to develop the meta-language to verbally explain it (Tytler, et al., 2014). Another important aspect of this study is determining the significant relationship between students' conceptual understanding on the causes-effects and images on the concepts of climate change. The result of this research will reveal on the strengths and weaknesses of the students of a particular concept. It will provide teachers opportunities to evaluate and refine their teaching strategies.

Furthermore, Figure 1 is the conceptual framework of this study which aimed to determine the students' conceptual understanding and images of students on the concepts of climate change using the EITI. The developed EITI was used to determine the students' conceptual understanding and images on the concepts of the climate change such as: 1) temperature; 2) rainfall; 3) cyclone; 4) drought; 5) extreme meteorological condition and 6) greenhouse gases.

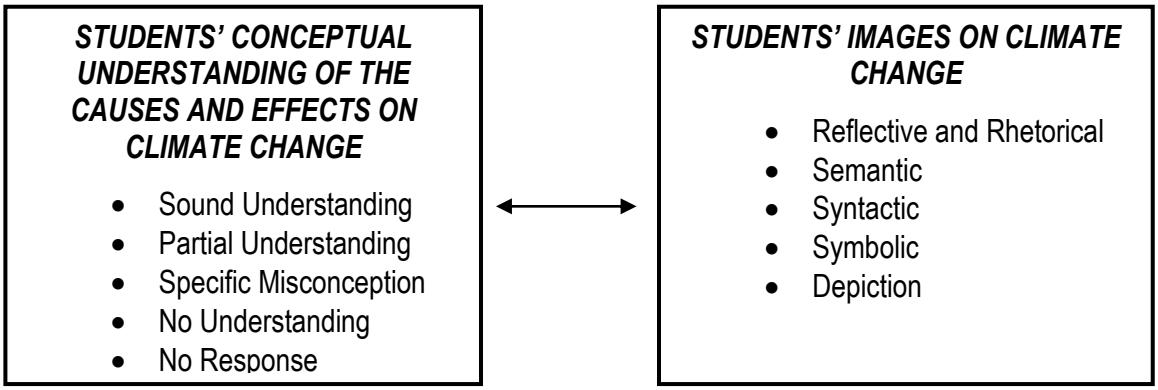


Figure 1. Conceptual Framework of the Research

The different concepts are adapted from the previous research study of PAGASA (2011) and incorporating the concept on greenhouse gases based from the suggestion of an expert from

Department of Natural Resources and Environment (DENR) during the validation process of the task instrument. The students' conceptual understanding and images on the different concepts of climate change were evaluated using the adapted and modified rubric of Kozma and Russel (2005). Specifically, students' conceptual understanding on the causes and effects of the different concepts in climate change were classified as *sound understanding, partial understanding, specific misconception, no understanding and no response*. *Sound understanding* means that the responses of students include all components or some of the scientifically accepted response. On the other hand, students' response described as *partial understanding* means that the responses may include at least one of the components of the acceptable scientific ideas but may also contain a kind of misconception. Moreover, students' responses described as *specific misconception* contain responses that are descriptive, incorrect or illogical information, while students' responses described as *no understanding* means that the responses are irrelevant or contain uncodable responses or a phrase like *"I don't understand."* Lastly, students who have no answer or have the following forms of responses: *"No answer," I don't know," "I have no idea"* are described as *no response*. The said definitions of each descriptions of students' conceptual understanding were presented in Table 8.

On the other hand, the students' images are classified as *reflective and rhetorical, semantic, syntactic, symbolic and depiction*. *Reflective and rhetorical* means that the students explain the relationship between physical attributes and underlying process by using one or more images on the concept of climate change, while students' images that are presented using formal symbol to show the underlying non-observable process are described as *semantic*, and then students' images that generate images both observed and unobserved physical attributes are described as *syntactic*. Moreover, the students' images that are described as *symbolic* means that

the images are based on physical attributes but include symbols thus, examples of symbolic elements are arrows that represent motion or time. Lastly, students that generate images that are based on the physical attributes are described as *depiction*. In addition, the descriptions of students' images of each classification were presented in Table 9. Furthermore, this present study also explored the possible significant relationship that may exist between students' conceptual understanding on the causes and effects of the different concepts in climate change with the students' images or representation on the said concepts in climate change as to counter validate the assumptions of this study and the claims of previous studies on students' conceptual understanding and visual representations or images on the different fields and topics of science.

Statement of the Problem

The aim of this study was to determine students' conceptual understanding and images on the different concepts of climate change using a developed and validated "Explain and Illustrate Task Instrument."

More specifically, the study answered the following questions:

1. What are the students' conceptual understanding of the causes-and effects of the following concepts of climate change, namely:
    a. temperature,
    b. rainfall,
    c. cyclone,
    d. drought,
    e. extreme meteorological condition, and
    f. greenhouse gases?

2. What are the students' images on the above-mentioned concepts of climate change?

3. Are there significant relationships existing between the following:

   a. students' conceptual understanding on the causes and effects of the different concepts of climate change,

   b. students' conceptual understanding on the causes and images of the different concepts of climate change and

   c. students' conceptual understanding on the effects and images of the different concepts of climate change?

Significance of the Study

The results and findings of the study may be substantial in determining the students' conceptual understanding and images on the different concepts of climate change. It may also serve as one of the possible references for the science teachers in making instructional materials and activities in teaching earth science and physical science. The study may help earth science education researchers determine existing problems behind the students' conceptual understanding and images of climate change and find ways to develop more applicable and suitable approach on strategizing the students' need on earth science.

The students have been affected by the effects of climate change, especially on their education that is why it is important to enhance students' knowledge and understanding on climate change concepts and issues. This also may serve as one of the references for future studies. Thus, for succeeding research, there must be a developed instructional materials in order to improve the students' conceptual understanding images on the different concepts of climate change.

Furthermore, this study can provide ideas to teachers on what teaching strategies are applicable in teaching earth science, after assessing the students' conceptual understanding images specifically the different concepts in relation to climate change. This research will also confirm the students' misconceptions about the different concepts of climate change.

Scope and Limitation of the Study

The research aimed to determine the students' conceptual understanding and images on the concepts on climate change using the validated EITI. There were six (6) selected climate change concepts based from the previous research of Department of Science and Technology - Philippine Atmospheric, Geophysical & Astronomical Services Administration (DOST-PAGASA) and was suggested by the Department of Natural Resources and Environment (DENR) to include the concept on greenhouse gases. Moreover, these are the different climate change concepts a) temperature b) rainfall c) cyclones d) drought e) extreme meteorological condition and e) greenhouse gases. These climate change concepts were significant according to Servando (2011) of PAGASA because the effects of climate change have threatened the vulnerable country especially the Philippines. Also, PAGASA needs to have some scientific basis for the purpose of adaptation and also for vulnerability assessment. It will also provide students and teachers to understand the future changes in climate and how it affects the Philippines in the future. In addition, these concepts are the common factors that are connected to climate change according to National Oceanic and Atmospheric Administration (NOOA) in 2009.

Furthermore, the respondents were Grade Ten (10) students from three (3) selected public schools in Malabon National High School, Navotas National High School and Valenzuela

National High School. The researcher chose the above-mentioned schools based on the frequent heavy flooding that the schools have been experiencing and as per reported from the list of PAGASA and MMDA of areas in NCR including other regions that were prone to flood in 2015.

However, due to inevitable circumstances, the principal from Malabon National High School did not grant the request to administer the task instrument due to the school activities of the school. The researcher had selected one additional school as the respondent of the study which is the Parañaque National High School. The said school also often experience flooding during rainy season since it is situated near a river system in Parañaque. The EITI was administered by the researcher and there were two (2) sections from each school who answered the EITI for about forty five (45) minutes with the consent of the school head.

Moreover, the students' conceptual understanding and images on the different concepts on climate change were determined using the adapted scoring rubrics that were patterned from Kozma and Russel (2005). There was a separate scoring rubric for the students' conceptual understanding and images (Appendix D).

Definition of Terms

The following terms are conceptually and operationally defined according or how it is used pertinent to the study.

1. Change in Climate. It refers to the significant change in the measures of climate lasting for an extended period of time. It is attributed to changes in precipitation, intensity of tropical cyclones, temperature and frequency of extreme weather events that occur several decades or longer according to United States Environmental Protection Agency (EPA), (2016). The different climate change concepts are stated below:

a. Temperature. It causes the major increase in the number of hot days and warm nights, but decrease of cold days and cool nights (Cinco, et al., 2013).

b. Rainfall. It is caused by El Niño - Southern Oscillation (ENSO) that caused drought in many areas and ENSO cold events (La Niña) caused excessive rainfall (PAGASA, 2007).

c. Cyclone. It is called typhoon and a generic term for any intense circulating weather system over tropical seas and oceans. (*Retrieved from http://www.rappler.com/moveph/issues/disasters/preparedness/76777-classification-tropical-cyclones-philippines on May 29, 2016).*

d. Drought. It is defined as three (3) consecutive months of "way below normal" more than 60 percent below average rainfall (Malano, 2015).

e. Extreme Meteorological Condition. It refers to the extreme weather/climate events like intense rains, increase in the frequency of hot days and warm days (DOST-PAGASA)

f. Increase of Greenhouse Gases. It refers to the human-induced activities that add more carbon dioxide such as burning fossil fuels for energy (WWF, 2016).

2. Students' Conceptual Understanding. It is defined as the students' personal understanding on the concept by providing answers on the causes and effects of climate change on the task instrument. The students' conceptual understanding was determined with the use of adapted and revised rubric from Kozma and Russel (2005). These are the five (5) descriptions of students' conceptual understanding and stated below:

a. Sound understanding. It is when the students' responses include all components or some of the scientifically accepted response.

b. **Partial understanding**. It is when the students' responses may include at least one of the components of the acceptable scientific ideas but may contain a kind of misconception.

c. **Specific misconception**. It is when the students' response may include descriptive, incorrect or illogical information.

d. **No understanding**. It is when the students' response is part of, or full form of the question or task; or it may be any irrelevant or uncodable responses; or of a phrase like "I don't understand.

e. **No response**. It is when the students have no answer or have the following forms and the likes of responses: "No answer," "I don't know," "I have no idea.

3. **Students' Images.** It is defined as the students' personal illustration or representation on the different concepts of climate change by providing answers on the EITI. The students' images are determined with the use of adapted and revised rubric from Kozma and Russel (2005). Furthermore, to show in a picture, these are the descriptions of students' images on the concepts of climate change stated below:

a. **Reflective and rhetorical**. It is when the students generate a representation or images that can explain the relationship physical attributes and underlying process and can use one or more representation or images on the different concepts of climate change.

b. **Semantic**. It is when students generate a representation or images on climate by using formal symbol to represent underlying non-observable processes.

c. **Syntactic**. It is the images when students generate a representation or images on climate change based both observed and unobserved physical attributes.

d. **Symbolic**. It is the images when students generate representation or images on climate

change based on the physical attribute but includes symbols.

f. Depiction. It is the images when the students generate representation or images on climate change based on the physical attribute.

Chapter 2

REVIEW OF RELATED LITERATURE

This chapter discussed the causes and effects of climate change due to natural phenomenon and particularly the man-made activities that accelerated climate change. On the other hand, the literature from the previous researchers on students' conceptual understanding and images in science and especially on climate change issues were also discussed.

Climate change is a challenge at present time. The adverse consequence had a permanent effect to the environment, social including the economic status. Moreover, Holdren (2006) defined climate change as any measurable trend in global climate towards extreme, which is in addition to rising global temperatures cited by Ochieng (2013). The concept of climate change is not new because the climate on Earth has always been changing due to the influence of its own internal dynamics and natural external factors. However, due to man-made or anthropogenic activities it has been recognized to accelerate and magnify the effects of climate change. The International Geosphere-Biosphere Programme (IGBP) (2015) mentioned that the Earth system has a domino-effect that if anthropogenic activities affect the earth system it does not operate in a simple cause-effect response. Therefore, a single human-induced can change and can cause large number of responses in the Earth system, when themselves flow to the system and often merging with patterns of natural variability. In fact, there was an increase of greenhouse gases such as methane, nitrous oxides to the Earth's temperature that caused global temperatures to rise causing climate change (Shepardson, et al., 2012). More specifically, based on the report of Climate Change Commission in the Philippines (2007) on the manifestations of climate change

in form of rising temperature, variability of precipitation, frequency and intensity of typhoons, sea level elevation, and the risk of droughts, floods, heat waves, and forest and grassland fires have impacts to the economy, environment and communities. Besides, the increase of temperature is evident in the Philippines like the rest of the world. Moreover, according to the research conducted by the Greenpeace in the Philippines using the Geographic Information Systems (GIS), the region in the mountainous Cordillera Administrative Region (CAR) is not in danger of sea level rise but it is highly affected by the typhoons and that increases the precipitation while the rest of the regions in the Philippines could experience the effect extreme weather that result to disaster such as flash floods and landslides and also in the areas that are below sea level. Thus, the country has the second largest coral reef cover in the world and a coastline is roughly equivalent of the earth's circumference because of being an archipelagic the country is threatened by the effect of climate change (Jabines, et al., 2007). Furthermore, the urban areas specifically Metro Manila is the most vulnerable to the effects of climate change and ranked seventh in Southeast Asia which also resulted to the damage of agriculture due to the typhoons, droughts and floods that has already reached PhP 12 billion according to Aguja, et al., 2015. There are also evidences of extreme weather event for instance, that flooded Metro Manila in September 2009 due to the intense rainfall due to the passage of Tropical Storm Ondoy (Esquivel, 2016). Furthermore, promoting the importance of understanding the exposure and vulnerability on the effects of climate change can be effective for adaptation and risk management (Barros, et al., 2012; IPCC, 2012).

Students' Conceptual Understanding on Climate Change

The importance of science literacy can help student understand and shape their lives. Thus, the students can have the abilities to correlate and understand which is more important behind the rote calculations and the common textbook knowledge stressed by Howard (2011) when students have conceptual understanding on a certain concept in science. Also, by understanding science concepts it can assist students to interact to their environment and can even ask questions and seek for answers. In addition, to improve students' conceptual understanding is by asking questions. When students ask questions, it can also provide answers to the questions or inquiries on a certain concept. Furthermore, (Gautier, et al., 2005) emphasized the importance of asking questions to develop students' learning and understanding. Thus, sound understanding on the different concepts of climate change is more than finding the "correct" answers according to Korsager (2013). The importance of trying to grasp relations between climate and climate change issues is a way to expand a complete understanding by focusing on causalities. Thus, causalities also refer to the patterns of interaction between causes and effects (Korsager, 2013; Grotzer and Perkins, 2000; Perkins and Grotzer, 2005). A climate literate person needs to have knowledge on Earth's climate system and an understanding on how human-induced activities are influencing Earth's climate system (Nam, 2011). The conceptual change is attained through critical evaluation of students' knowledge (Lombardi, 2012). Moreover, global understanding refers to the ability to identify cause-effect patterns over a long distance (Korsager, 2013; NASA, 2012). In fact, the advantage of learning science with understanding is the efficiency because the organization improves retention, promotes fluency, and facilitates learning material than by simply memorizing concepts. However, the teacher should also consider other alternative techniques for assessing students' conceptual understanding and

concepts that can be understood and used at different levels. Also, it was suggested by (Lan, 2005; Oversby, 2002) that teachers have many ways to assess the current conceptual understanding of students. The students' knowledge on global warming will help students realize the importance of taking care Mother Earth (Tsantakis, 2009; Cleaver, 2007; Oluk S. and Ozalp I., 2007; Mason, et al, 1998). As educational researchers, we must explore effective methods to generate changes in students' epistemic cognition to be more critically evaluative of hypotheses and theories in order to increase their plausibility perceptions of scientific claims because what students know and understand about environmental issues will ultimately influence their environmental decisions.

Moreover, there is also a need to reconstruct conceptual understanding of students to improve understanding of science according to Sinatra and Chinn (2011). The students' conceptions of the different concept of climate change also help educators to understand how students make sense of what they are learning and also to correct misconceptions and equip the students to successfully connect the dots from knowledge to action thus, practical application of knowledge is the most important (McNeill and Vaughnn (2012). Likewise, students' cconceptual understanding on the concept of climate change phenomenon must be deep enough to guide them into practical application. UNESCO (2011) emphasized to address the mitigation and adaptation by increasing the knowledge and understanding on the causes and impact of climate change (Alan, 2013).

Furthermore, researchers also found out that students have misconception Boylan (2008). For instance, Papadimitriou (2004) reported in his research that both students' and adults' understanding pertaining to environmental concepts also with the concepts on climate change have misconceptions. He also found out that the students are confused with weather and climate,

climate change is linked to air pollution and environmental pollution and climate change is associated with ozone layer depletion. Thus, climate change is a critical issue with serious impacts that is why climate literacy is essential. However, research shows that students do not have the knowledge to understand physical climate system and human interactions (Nam, 2011; Boyes, 1995; Dove, 1996; Summers, et al., 2001; Trend, 2001). Even the college students are unaware that natural events could also cause climate change; for example, volcanic activity. However, in spite of its relevance climate change knowledge remains to be inaccurate and has incomplete conceptualizations (Chang and Pascua, 2016; Wang, 2004). The main goal of teaching science is to enhance of learners' scientific literacy. Climate change is considered as a complex issue that many lay people not only in the developing countries may have difficulties in grasping what causes climate change (Tschakert, et al., 2009). Therefore, learners' conceptual understanding is always regarded as one of the most important issues in research in terms of evaluating science learning (Chang, 2011; Eylon and Linn, 1988).

There are also misconceptions on the concepts related to heat and temperature is related to physical environment of living organism. Thus, heat and temperature are not directly observable quantities, concepts developed by the students originated from the interpretation of ideas gained from everyday experiences (Baser, 2006; Leura, Otto and Zitzewit, 2005). Another misconception is about the characteristics of atmospheric composition and human interactions. It is important for science teachers to determine the current of understanding because according to the research of Summers, et al., 2000 that there are students who do not understand how human activities increase the concentration of greenhouse gases or the effect of the increase of greenhouse gases in the atmosphere. There are some instances that students' conceptual understanding are constructed incorrectly especially when there is pre-existing or previous

knowledge that was faulty or incomplete likewise the students have constructed conceptual understanding clearly (Moe, 2011; Bransford, et al., 2000; von-Glaserfeld, 1989; Novak, 1977).

It was suggested that when teachers test new alternative assessment strategies will lead to a meaningful conceptual understanding of students that science educators need to invest. One example of alternative assessment is the use of conceptual map method to determine students' understanding of global climate change likewise, Gautier (2005) had also introduced two conceptual mapping activities to help assess students' knowledge and understanding and to uncover misconception of students on the concept of climate change. The use of concept map can demonstrate learning and also it can provide information about gaps in knowledge including misconception of students. It has been revealed that higher-level student questions are related to a deeper understanding of the subject matter (Harper, Etkina, and Lin, 2003). Furthermore, there is a need to rework prior understanding of students especially in the different concepts of science. Thus, according to Slinger (2011) and was also cited by Biddulph (2015) that assertion for the development of conceptual understanding of students can happen in three ways such as:

1. Differentiation which happens when an existing concept may be differentiated into two or more new concepts. For example, in differentiating the natural and man-made causes of climate change,

2. Coalescence means when two existing concepts can be "interdefined". For example, the word powerlessness and exclusion are two concepts used to understand group of people such that powerlessness is the effect of exclusion from economic, political, cultural and social processes and

3. Redefinition means when concepts can be redefined when considered in terms of relationships as opposed to key properties. For example, using a pointing map can also mean a particular location or it can also mean connectedness of a certain concept.

Furthermore, eliminating the lack of perceptions on the concepts of climate change will result to improving students' conceptual understanding according to Cordero (2008) as cited by Pitpitunge (2013). Also, Pitpitunge (2013) suggested that increasing the knowledge and understanding of students on the different concepts of climate change such as the basic concepts, effects and causes of climate change should involve active learning method by engaging the students in learning process because climate change education should be scientifically and socially oriented. In effect, the students are knowledgeable on the mitigation strategies and how deal with the impacts of climate change.

Students' Images in Science

It is significant for the students to learn how to create representations on the different scientific concepts, processes and findings (Tytler, et al., 2014). He also added that before the students can have a chance to verbally explain a particular concept it is possible for the students to demonstrate understanding with a representation. Thus, there were studies that the emphasized the importance of teacher-student negotiation of the meanings and evident, visual, mathematical and gestural representations in science (Tytler, et al., 2014). For instance, physics teachers used the representation approach that can provide teacher a better reasoning and ability and conceptual understanding according to Sutopo (2012). Furthermore, Evagorou, et al., 2015 and Pauwels (2006) asserted that visual representation in science refers to the objects that are believed to some kind of material or physical existence which also refer to purely mental,

conceptual, and abstract constructs which is considered a complex process. Also, the use of images can help solve problems. The use of drawing, visual diagrams and graphs and other representations can also integrate mathematical formulas and algebraic derivations as well as quantitative calculations, however, scientific event or problems can also be purely verbal-conceptual terms according to Lemke, 2004.Thus, images can also help in understanding problems, guiding problems, solving methods and how it affects mental structures (Gursel, 2011; Owens and Clements, 1998). Moreover, teaching mathematics, reading and especially science and technology are using visualization to understand the different concepts (Vavra, et al., 2011). Consequently, the advantage of using representation is the existence of an idea especially for the students according to Gilbert, 2010. He also added that there are two ontological forms of visual representations. First is known as mental images which is also called as personal mental constructions of the individual and second is known as external representations which are open to inspection by others. Moreover, the use of visual representation in science concepts communication has an important role (Cook, 2011; Ametller and Pinto, 2002). Thus, there are students who can obtain knowledge that may not be get from verbal explanations alone (Cook, 2011; Patrick, Carter and Wiebe, 2005). There was also an advantage of using arrows for instance, to display the flow of events, mixing of real and symbolic entities, highlighting of certain words or images, wording of verbal explanations, and integrating several images into one all have been effective to students' understanding of images (Cook, 2011; Styliaiduo and Ormerod, 2002). Thus, images and objects can provide students an opportunity to make personal connections to the materials being used by pointing out different types of styles, images and colors and it can be a starting point to have conversation (Sieber and Hatcher, 2012). Because in science communication it is facilitated by presenting summaries of data that can be taken in the

form of tables, graphs, images thus it conveyed information about the quality or information of the scientific data (McCabe and Castel, 2007). In physics, imagery is defined as a universal language of the mind because its uses imagination to think in pictures, sounds, smells, tastes, or touch sensations (Dori and Belcher, 2005; Manhart, 2003). Also, Albert Einstein said that "imagination is more important than knowledge, thus knowledge is limited (Viereck, 1929). Thus, according to some scientists, the students' images are accepted as one of the important factors that also influenced students' interest, attitudes toward learning science and having science-related careers in the future (Ozel, 2012; Boylan, Hill, Wallace and Wheeler, 1992).

Furthermore, the students have different manner of interpreting, understanding and recalling information according to Olmanson, 2012. When learners form these ideas and beliefs, they usually create images and mental models, visual representations and drawing to provide glimpse of students perceptions of scientist were commented on by many researchers such as Picker and Berry (2000, 2001-2002) as cited by Avilla, (2009). It facilitates people to understand the things around them even if they have not yet experienced or can only hear or read about it when constructing mental models or a representation of a certain concept. According to Schwartz, 2006 imagery is the process of construction of images in the mind's eye and it has an implication on learning spatial representation. In addition, the students can integrate non-perceptual knowledge that allows them to imagine or picture out things even if they have not seen. The students can recall things better through visual which is also known as special representation thus, the memories of the students are expansive. In addition, imagery can able students to create images and it can go beyond world. Like for example, students can imagine a rainbow even if they have never seen or heard about it. The representational competence of

scoring rubrics from Kozma and Russel (2005) in determining the students' understanding and representational competence and there are five (5) descriptions of students' images.

Reflective and rhetorical when the student uses one or more representation. Moreover, the student can give explanation on the relationship between physical properties and underlying entities and properties.

Semantic when the student generates a representation to represent a physical phenomenon by using formal symbol correctly in order to represent underlying, non-observable entities and processes which mean the student can produce based on syntactic rules and also its meaning. Moreover, the students can also give meaning for a several kinds of representation.

Syntactic means the use of formal representation means when the student generates representation based on observed and unobserved features but the underlying process may not be scientifically correct. The student also focuses on the syntax used instead of the meaning of the representation.

Symbolic when the student generates representation based on the physical attributes but also includes some symbols. Thus, the examples of symbolic elements are arrows that represent motion or time.

Depiction when the student generates representation or images on the phenomenon based only on its physical attributes.

Furthermore, it is an advantage for the students to comprehend the different concepts with the use of concrete models, image representation, animation and simulation (Tasker and Dalton, 2006). The internal representations are connected to the external representations. Thus, Sunyono, et al., 2015; Solaz-Portolės & Loppez, 2007 cited that in cognitive psychology expert

Johnson-Laird was challenged to explain the individual reasoning in the process of solving syllogism problems. This is due to the forming internal representation in the form of mental model in the working memory regarding the world and combining also the information stored in the long-term memory. Also, research conducted by Shonbon and Anderson (2009) found out that there are three (3) basic concepts of reasoning ability available to the student within their external representation are the following: 1) reasoning means the students' conceptual knowledge 2) conceptual knowledge means the skills to select student representation 3) representation means mode of students representation. The mode of representation of students can also differ based on reasoning and conceptual knowledge. Furthermore, when students' answers were interpreted to mental model is the ability of students to accurately interpret and explain external representation phenomenon (Sunyono, et al., 2015; Park, et al., 2009). There are also students who preferred simple visualization in addition to verbal lessons thus; it can improve students' motivation (Sunyono, et al., 2015; Sanky, 2005; Chittleborough, 2004; Stokes, 2002). It was also stressed out by Kress (2010) communication can be delivered in many ways to represent a message. Moreover, it can be employed such as spoken words, written words, images and diagrams (Nixon, 2012; Kress, 2010; Jewitt, Kress, Ogborn, and Tsatsarelis, 2001). There are also challenges with multiple representations according to Ainsworth (2006). One of the many challenges is that students have a tendency to focus on the surface features of a representation rather than negotiating the deeper meaning and conceptual meaning (Kozma, 2003; Schonborn and Anderson, 2009; Wu, Krajcik and Soloway, 2001). There are three benefits with multiple representation according to previous studies (Eilam and Poyas, 2008; Prain, 2006; Van der Meij and de Jong, 2006; Wu et al., 2001). First benefit of multiple representations serves the functions of complementing, constraining and constructing. It is to complement each other,

multiple representations to add greater information than just one representation (e.g. velocity-time graph and acceleration-time graph). The second reason is students' understanding may be enhanced when learning from multiple representations is explained by the generative theory of multimedia learning (Adadan, et al., 2009; Mayer, 1997, 2003). Thus, there are three conditions of human learning, and these are a) the dual-channel (also known as dual-coding) assumption), which means there are two channels, visual channel and verbal channel and human brain code the information separately, b) the limited capacity assumption, each channels can only process a limited amount of information c) the active learning assumption, when the information get processed that is time that is actively selected by the learner. Therefore, the information is presented as visual and verbal representations and the information can enter both channels at the same time. To enhance students' learning is due to the multiple representations which is a result of creating representation or images is the third reason (Kress, 2010; Hand, et al., 2009; Márquez, Izquierdo, and Espinet, 2006; Prain, 2006; Jewitt, et al., 2001; Hand et al., 1999; Lesh, Post, and Behr, 1987). Thus, the examples are the use of symbols such as logos, maps, arrows, road signs and icons that someone can recall with little effort (Asan, 2007; Lawson, 1994). Visual representation allows the development of a holistic understanding that words alone cannot convey.

Students' Images on Climate Change

Furthermore, images can be used in teaching climate change concepts to the students. Nowadays there are a lot of issues on climate change and imagery or representation has an important role in increasing the sense of importance and even encouraging the feelings of being able to do something of the issue about climate change (O'Neil, 2012). The understanding on the

nature of climate change, effects and options for adaptation is still immature (Barros, et al., 2014). There are also studies that there is a gap between knowledge, attitude and action (Hung, 2014; Lee, Lester, Lambert and Jean-Baptiste, 2007; Anderson and Wallin, 2000). The use of science visualization were proven effective especially when it is designed according to specific cognitive and affective needs of the target audience, specifically the students (Homer, 2009; Plass, et al., 2009; Rieber, 2005). The students' written words and drawings are conceptual visualizations or representations of their understandings of global warming and climate change that contain a number of individual. Global warming and climate change concepts that are embodied with meaning (Kress, et al., 2001; Alerby, 2000). Thus, students' conceptions may be constructed from their graphic representations (Shepardson, 2011; Vosniadou and Brewer, 1992). There are recent findings that a certain visual or mental imagery can provoke counter-productive responses and so it is important to understand how student construct and represent the concepts on climate change (Moloney, et al., 2014; Cole, 2005). The climate change education is also considered as a mitigation strategy and it is also dependent on the effectiveness of the curriculum. Thus, the curriculum can only be designed and implemented successfully if we understand where students are in terms of their knowledge and disposition about the issue on climate change (Hung, 2014). Furthermore, the students in the Philippines are one of the most affected of heavy rainfall, strong typhoons and other extreme weather conditions. Students' conceptual understanding and images of students on the different concepts on climate change can help them realize the importance of taking care of their environment. Thus, imagery is important in increasing climate change awareness with the use of a representation also, effective in promoting the importance and showing concern towards climate change (Salinger, 2016; Smith and Joffe, 2009).

Synthesis

Teaching climate change to students is challenging to teachers according to research (Korsager, 2012; Liu and Hmelo-Silver, 2009; Mohan, Chen and Anderson, 2009; Cordero, Todd and Abellera, 2008; Gowda, et al., 1997). Korsager (2012) added that one reason for the lack of understanding of the topic could be the way climate change is taught as emphasized by the researchers (Rebich and Gautier, 2005; Moser and Dilling, 2004; Dove, 1996). The results of this research will also determine pre-existing knowledge and misconceptions of students thus, prior knowledge of the students will have conflict with the scientific realities (Birisci and Metin, 2010; Yuruk, 2000). In order to facilitate students' conceptual development specifically the concept of greenhouse gases, through the learning materials which aimed to encourage active cognitive learning in order to achieve deep understanding (Reinfried, et al., 2012). There are also different studies (Robbegalle, et al., 2014; Harsch and Barke, 2012; Niebert and Gropengiesser, 2012; Reinfried, Aeschbacher and Rottermann, 2012; Osterlind, 2005; Mason and Santi, 1998) that provided indication on how to cope with teaching environmental phenomena for instance, the concept of greenhouse effect, acid rain and depletion of stratospheric ozone. However, due to lack of research about students' conceptions of these phenomena and how their development during teaching-learning arrangement can be assessed (Robbegalle, et al., 2014). Moreover, Pitpitunge, et al., 2015 asserted that determining the students' knowledge including specific misconceptions can provide information for the integration of climate change concepts in the new curriculum and also for the use of interdisciplinary strategies in teaching. He also suggested to incorporate the following areas of climate change in the development of interdisciplinary activities and programmes for the

biological and physical sciences. Furthermore, for the biological sciences these are the common issues that should emphasize the following:

1) vulnerability of the Philippines on climate change,

2) impact of climate change on the ecological systems of the Philippines, specifically the endemic plants and animals and lastly,

3) root crop production as climate change adaptation strategies.

Moreover, for the physical science, it is also important to include the following global issues:

1) chemistry of climate change,

2) global warming, greenhouse effect and climate change,

3) energy and climate change,

4) impact of increasing temperature on natural resources, and

5) technological advancement and climate change mitigation and adaptation.

These sciences played an important role in relation to the concept of climate change. Like for instance, the concept of greenhouse gases could be easily grasped by the students by determining the process of production of greenhouse gases both natural and man-made causes. Consequently, the importance of this research is to cope the challenges of climate change consequences such as rise in sea level and extreme weather disturbances resulting to drought, flood and stronger typhoons. It is also to encourage support from the younger generations to ensure more sustainable future. However, these young people specifically the students are not aware that simple daily activities can contribute climate change (Sarmiento et al., 2016). Furthermore, there are fear-inducing representations of climate change that are promoted worldwide however; there is lack of literature pertaining to the impact of climate change (O'neill, 2009).

Chapter 3

METHODOLOGY

This chapter presents in detail on the design and methodology employed in the conduct the study on determining the students' conceptual understanding on the causes-effects and images on the different concepts of climate change. The source of data, research participants, research instruments, data gathering and data analysis procedure, and the statistical treatment utilized in the study were discussed thoroughly in this chapter.

Research Design

The researcher employed a descriptive correlation design in attaining the objectives of this study. The study focused on determining the students' conceptual understanding and images on the different concepts of climate change, as well as, in probing the significant relationship existing with students' conceptual understanding on the causes-effects and images of the different concepts on climate change.

The researcher developed a validated EITI with corresponding rubric as a scoring guide in assessing the students' conceptual understanding and images on the concepts on climate change. Moreover, survey method was employed in administering the EITI to the respondents from three public schools. The patterns of the students' responses and illustrations on the said instrument were analyzed and tallied to further attain the aim of this study, and lastly the significant relationship on their conceptual understanding and images were also determined.

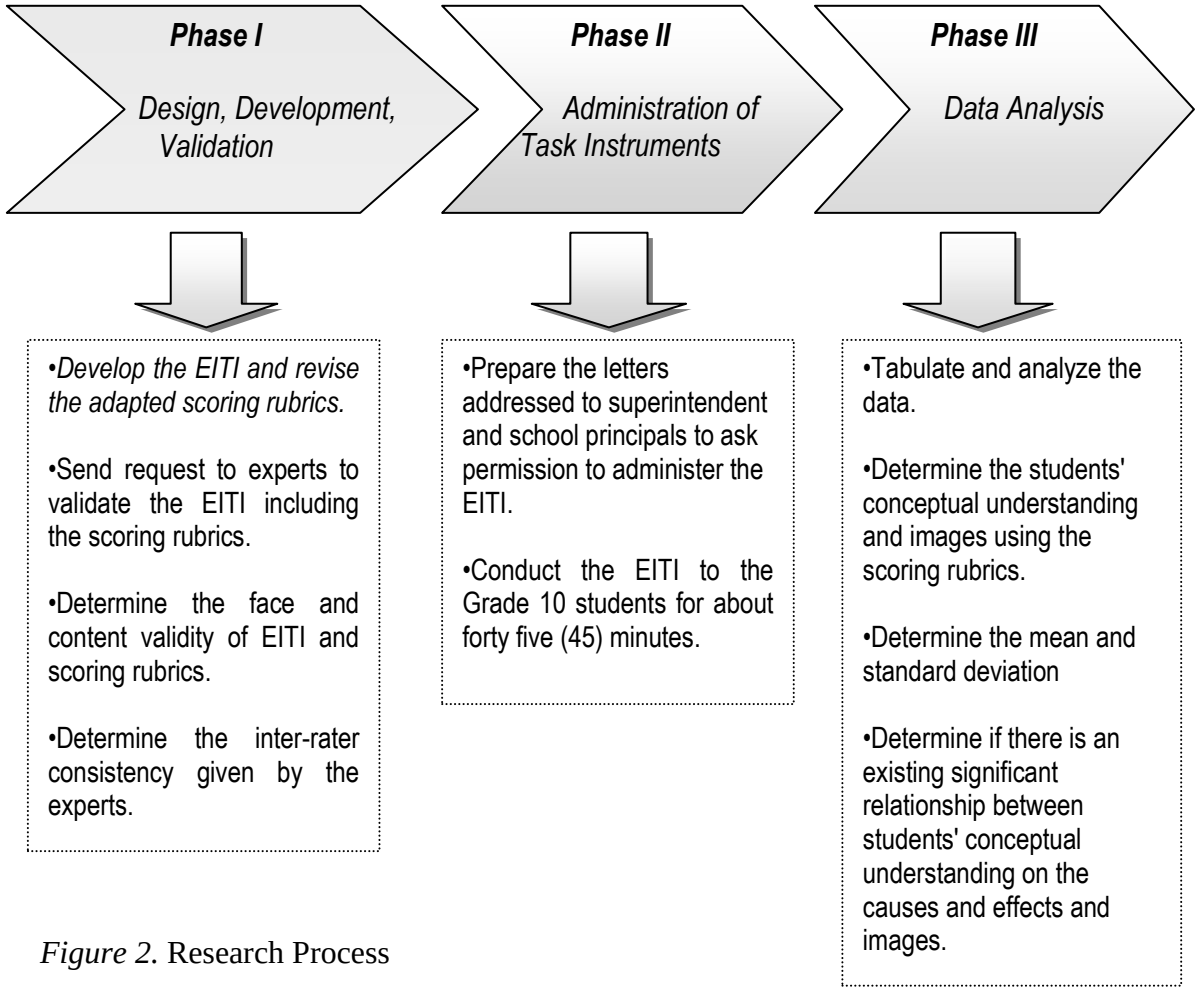


Figure 2. Research Process

Moreover, to illustrate the overall result of students' conceptual understanding on the causes and effects on the different concepts of climate change, a five point Likert scale is illustrated in Table 1. The students are described with sound understanding if the weighted mean is between 4.20 – 5.00 while students that are described as no response has a weighted mean is between 1.00 – 1.79. On the other hand, the students that are described with no understanding that has a mean interval of 1.80 – 2.59 while students with specific misconception has a mean interval of 2.60 – 3.39 and lastly, students with partial understanding has a weighted mean between 3.40 – 4.19.

Table 1.

Range and Interpretation of Overall Students' Conceptual Understanding

Unit Weight (Assigned Values)	Weighted Mean Interval	Interpretation
5	4.20 - 5.00	Sound Understanding
4	3.40 - 4.19	Partial Understanding
3	2.60 - 3.39	Specific Misconception
2	1.80 - 2.59	No Understanding
1	1.00 - 1.79	No Response

Table 2.

Range and Interpretation of Overall Students' Images

Unit Weight (Assigned Values)	Weighted Mean Interval	Verbal Interpretation
5	4.20 - 5.00	Reflective and Rhetorical
4	3.40 - 4.19	Semantic
3	2.60 - 3.39	Syntactic
2	1.80 - 2.59	Symbolic
1	1.00 - 1.79	Depiction

Furthermore, Table 2 illustrates the overall students' images on the different concepts of climate change. The highest mean value which is 4.20 - 5.00 means reflective and rhetorical means the students can explain the relationship between physical attributes and underlying process and can use one or more images while the value of 1.0 - 1.79 is described as depiction means the students can generate images on climate change based on physical attributes. Thus,

Table 2 is used as the basis for the range and interpretation of the overall students' images on the different concepts of climate change.

Research Participants

The respondents were chosen based on the list of flood prone areas provided by PAGASA and MMDA in 2015. Moreover, these are the three (3) public schools in Parañaque National High School, Navotas National High School and Valenzuela National High School and the study involved were from Grade 10 students and two (2) sections from each school.

The researcher administered the EITI with the endorsement from the Schools Division Office of Navotas, Valenzuela and Parañaque, and also with the recommendation and approval of the school principal, the researcher had administered the task instrument to the students for about forty five (45) minutes (Appendix A).

Table 3.

Profile of the Validators

Experts	Educational Attainment	Areas of Specialization
A	Doctorate Degree	Horticulture, Marine and Terrestrial Ecology and Biology
B	Master's Degree with PhD Units	Biology - Environmental Science
C	Master's Degree	Biology - Earth Science

Moreover, Table 3 shows the details of the profile of the evaluators who evaluated the EITI and scoring rubric that was used to determine the students' conceptual understanding on the

causes and effects and images on the different concepts of climate change. Also, determine the existing significant relationship between students' conceptual understanding and images.

Table 4.

Number of Respondents

School	Total No. of Students
Parañaque National High School	61
Navotas National High School	87
Valenzuela National High School	76
Total	**224**

On the other hand, the researcher had sought advice from the experts before the administration of the EITI. The instrument including the rubrics were evaluated and validated by experts to find out the level of acceptability of the task instrument (Appendix E). Thus, Table 4 shows that there were 224 respondents chosen from Parañaque National High School, Navotas National High School and Valenzuela National High School, respectively.

Research Instruments

During the course of the study, the researcher had sought advice from the expert to evaluate and validate the task instrument using the evaluation tool. It pertained to evaluation and the validation of task instrument and rubrics that were used by the researcher in order to determine the students' conceptual understanding on the causes and effects and images on the

different concepts of climate change and also the significant relationship between students' conceptual understanding and images on the different concept of climate change.

A. Evaluation Tool for the Validation of the Explain and Illustrate Task Instrument on Climate Change

The developed EITI and scoring rubric of the researcher were validated by experts and also reviewed by the research adviser. The researcher had prepared letters addressed to the evaluators and attached the validation tool including the scoring rubrics. The validation tool was used to find out the level of acceptance of the task instrument including the rubrics. The evaluators reviewed the content and face validity of the task instrument and scoring rubrics. The mean or the average rating on the content and face validity given by the researcher was computed. Furthermore, Table 5 below shows the interpretation of the computed average of the content and face validity tool (Appendix E).

Table 5.

Range and Interpretation of Values of the Face and Content Validation of the EITI.

Range	Interpretation
4.50 - 5.00	Totally Acceptable
3.50 - 4.49	Highly Acceptable
2.50 - 3.49	Fairly Acceptable
1.50 - 2.49	Slightly Acceptable
1.00 - 1.49	Totally Unacceptable

As shown in Table 5, the basis for the interpretation of face and content validity that was utilized by Bayonito (2015) and these ranges and interpretation to determine the scale of acceptability of the EITI and scoring rubrics after the validation process. The ratings given by the evaluators were computed to get the average and were the basis to find out the face validity and content validity of the EITI and the scoring rubrics.

The researcher sought assistance from three (3) experts to evaluate the face and content validities of the task instrument including the scoring rubrics before administering the EITI to the respondents. The EITI was divided into two (2) parts. Part I aimed to determine the students' conceptual understanding where the respondents provided answers on the causes and effects of each concept of climate change. On the other hand, Part II aimed to determine the students' images by creating an illustration or image for each concept of climate change. Moreover, the excerpts of the six-item task instrument were based on news articles and literature from PAGASA, DENR and Climate Change Commission. After being evaluated by the experts, the researcher prepared the letter addressed to the Schools Division Office of the three (3) public schools to ask permission in administering the task instrument to the students. The task instrument was administered by the researcher and the respondents were given forty-five (45) minutes to answer the task instrument.

The researcher adapted the evaluation tool for the validation of the EITI from Lansangan (2012). The said instrument is a five-point Likert scale divided into two parts, where the first part contains ten statements concerning the content validation of the EITI. The second part contains six statements concerning the face validity of the EITI.The experts had given their assessment on the level of acceptability of the instrument from 1 which is the lowest scale and 5

which is the highest scale for both content and face validities. The experts had provided comments and suggestions for the improvement of the instrument.

Moreover, the researcher had computed the scales given by the experts in determining the mean and standard deviation of the face and content validities of the task instrument. Furthermore, totally acceptable means the level of acceptance of the EITI has reached to the highest range of acceptability while the lowest rate which totally unacceptable means that the EITI needs to be revised by the researcher. Furthermore, the result of the face and content validity evaluation were tabulated in Table 6 and Table 7 in order to illustrate the validation result of the EITI.

Table 6 shows the result of the evaluation of the content validity of EITI together with scoring rubrics. It revealed that evaluators had given the highest rating in which students can reflect their own understanding and image on the different concepts of climate change which has an average of 5.00 which means totally acceptable while the lowest rating is the content on thought-provoking that requires usage of relevant science process skills has an average of 4.00 which means highly acceptable. Also, it has 4.67 average on the concepts that are based on Grade 10 competencies, instructions that are easy to follow and pointing system using a scoring rubric with a standard deviation of 0.47 which also means totally acceptable.

Furthermore, the overall content validity is 4.53 which mean that the EITI is totally acceptable and has a deviation of 0.242 agreement of the responses of the evaluators. The lowest the value of the deviation, means the higher agreement among the validators.

Table 6.

Summary of Content Validity Evaluation

CONTENT VALIDITY OF TASK INSTRUMENT	EXPERTS			$\bar{X}$	*SD*	Interpretation
	A	**B**	**C**			
a. enables the students to reflect their own on the different concepts on climate change.	5	5	5	5.00	0.00	Totally Acceptable
b. enables the students to reflect their own images about the different concepts on climate change.	5	5	5	5.00	0.00	Totally Acceptable
c. contains concepts that are based on the competencies of Grade 10 students.	4	5	5	4.67	0.47	Totally Acceptable
d. contains concepts that are easy to understand without confusing information.	4	4	5	4.33	0.47	Highly Acceptable
e. contains contents which are appropriate for the students' cognitive level.	4	4	5	4.33	0.47	Highly Acceptable
f. is thought-provoking and requires the usage of relevant science process skills	4	3	5	4.00	0.82	Highly Acceptable
g. gives information to assess students' prior concepts.	4	5	4	4.33	0.47	Highly Acceptable
h. uses languages in proper context.	4	5	4	4.33	0.47	Highly Acceptable
i. gives instructions that are easy to follow.	4	5	5	4.67	0.47	Totally Acceptable
j. clearly provides a pointing system through a rubric.	5	5	4	4.67	0.47	Totally Acceptable
				4.53	**0.242**	**Totally Acceptable**

Moreover, Table 7 shows the result of the evaluation of the face validity of EITI together with scoring rubrics. It revealed that evaluators had given highest rating on the face validity of giving enough space for students' responses and illustration, clear and organized layout and the use of familiar type task has an average of 5.00 which means totally acceptable. On the other

hand, the lowest rating given by the evaluator is the use of rubric, free of grammars and spelling errors, and the instruction, purpose and personal profile for the respondents has an average of 4.00 which means highly acceptable. As a result, the overall mean of the face validity of EITI is 4.28 which mean that EITI is highly acceptable with a deviation of 0.423. The lowest the result of deviation which means there is a highest agreement among the three (3) raters.

Table 7.

Summary of Face Validity Evaluation

FACE VALIDITY OF TASK INSTRUMENT	EXPERTS A	B	C	$\bar{X}$	*SD*	Interpretation
a. has enough space provided for the respondents' responses and illustrations.	5	5	5	5.00	0.00	Totally Acceptable
b. has clear and organized layout.	4	4	5	4.33	0.58	Highly Acceptable
c. uses rubric in giving equivalent weight for each item.	5	4	3	4.00	1.00	Highly Acceptable
d. use familiar type tasks.	4	4	5	4.33	0.58	Highly Acceptable
e. is free of grammar and spelling errors	4	4	4	4.00	1.00	Highly Acceptable
f. has a clear instruction, purpose and personal profile for the respondents.	4	4	4	4.00	1.00	Highly Acceptable
				4.28	**0.423**	**Highly Acceptable**

The researcher used the Fleiss Kappa to determine the inter-rater consistency of the response of the evaluators on the face and content validities of the EITI and the scoring rubrics.

This tool was used since there were three raters who evaluated the said instrument and rubrics. The range and interpretation were adopted from Weiner (2007) as presented in Table 8. Thus, when the kappa-statistic measure of agreement is scaled 0.81- 1.00, it suggests that the amount of agreement is almost perfect while if the agreement falls below 0.20, it suggests that there is a slight agreement between the ratings of the evaluators. Furthermore, Table 8 shows the results of the Fleiss Kappa and its interpretation on the agreements of the evaluators on the face and content validities of the EITI during the validation process.

Table 8.

Fleiss Kappa Scale and Interpretation

Range	**Interpretation**
0.81 - 1.00	Almost perfect
0.61 - 0.80	Substantial
0.41 - 0.60	Moderate
0.21 - 0.40	Fair
0.00 - 0.20	Slight
<0.00	Poor

Table 9 shows the result of inter-rater consistency of the content and face validities of EITI. Thus, Fleiss Kappa was recommended to determine the inter-rater consistency because there were three (3) raters who evaluated the EITI and the scoring rubrics.

Furthermore, the kappa-statistic measure agreement of content validity is 0.43 and a mean of 4.53 and deviation of 0.242 which means it has a moderate agreement between the

raters. On the other hand, the kappa-statistics measure agreement of face validity is 0.61 and a mean of 4.28 and deviation of 0.423 which means it has also a substantial face validity of the EITI. The results signify that the content and face of the EITI are both acceptable.

Table 9.

Result of Evaluator's Validation

Validation Section	$\bar{X}$	*SD*	Fleiss Kappa	Interpretation
Content	**4.53**	**0.242**	0.43	Moderate
Face	**4.28**	**0.423**	0.61	Substantial

B. Development of the Explain and Task Instrument (EITI)

The researcher aimed to find out the students' understanding on the causes and effects, and images on the different concepts of climate change. The different concepts on climate change are the following:

a. Temperature: The students were asked to provide the causes of increase of temperature and the effects to the rate of precipitation. The respondents were also asked to illustrate formation of rain in the presence of temperature.

b. Rainfall: The students were asked to provide possible causes on excessive precipitation or above normal rainfall and its effects especially in urban areas. Also, the students were asked to demonstrate the difference between northeast monsoon (amihan) and southwest monsoon (habagat) and the possible causes of excessive precipitation in the Philippines.

c. Cyclones: The students were asked to give the causes of increase of number of cyclones in the Philippines and its effect and to illustrate the formation of cyclones in the Pacific Ocean and demonstrate the possible causes of stronger tropical cyclones.

d. Droughts: The students were asked to explain the cause of El Niño resulting drought and its effects and to illustrate the formation of El Niño developed in the ocean resulting to drought.

e. Extreme meteorological conditions: The students were asked to give the possible causes of threatening meteorological condition and its effects and illustrate the concept of man-made (anthropogenic activities) which causes the development of extreme meteorological condition.

f. Greenhouse gases: The students were asked to write the causes of the increase of accumulation of greenhouse gases in the atmosphere and its possible effects and to illustrate greenhouse effect and demonstrating the effect if there is an increase of greenhouse gases.

C. Scoring Rubric

The students' conceptual understanding and images were determined with the used of scoring rubric adapted from Kozma and Russel (2005). There were two sets of rubrics that were used to determine the students' conceptual understanding and images of students on the different concepts of climate change. The students' conceptual understanding different descriptions are the following: sound understanding, partial understanding, specific misconception, no understanding and no response. On the other hand, the descriptions for the students' images are reflective and rhetorical, semantic, syntactic, symbolic and depiction (Appendix D).

Research Procedure

This descriptive study that was designed to determine students' conceptual understanding and images on the different concepts of climate change using the developed and validated task instrument with a rubric as a scoring guide in determining the students' conceptual understanding and images on the concepts on climate change that was conducted at the three (3) public schools that had experienced heavy flooding for School Year 2015-2016. This study had three (3) phases enumerated below:

Phase I. Design and Development

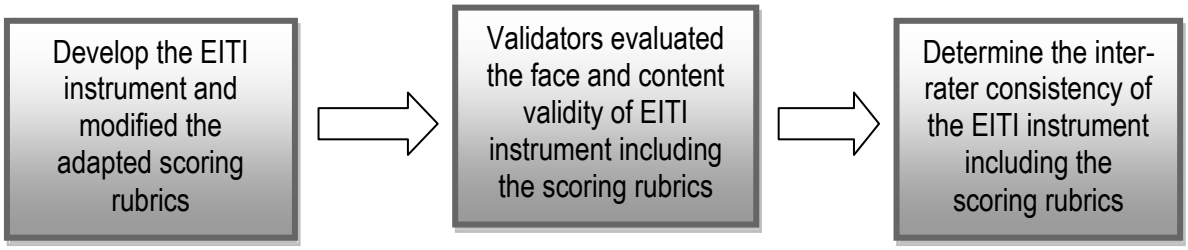


Figure 3. Development and Validation Process of the EITI instrument

The researcher had developed "Explain and Illustrate Task Instrument (EITI) that was used to determine students' conceptual understanding and images with the corresponding scoring rubrics as basis in determining the students' conceptual understanding and images on climate change. The evaluators evaluated the face validity and content validity of the task instrument and scoring rubrics. The evaluators were asked to put a check mark on the checklist. The highest rate was 5 and the lowest rate was 1. Figure 3 is the development and validation process of the EITI instrument.

Phase II. Administration of Task Instruments

The researcher prepared the letters addressed to the superintendent that was signed by the thesis adviser and was submitted to the Schools Division Office of the three (3) public schools to ask permission in administering the task instrument to the students. The superintendent gave a letter of endorsement addressed to the principal of the three (3) public schools (Appendix G).

Moreover, the researcher also prepared the letter to the principal with the attached letter of endorsement from the superintendent asking for the approval and recommended schedule to administer the task instrument. The administration of the task instrument should not interrupt the regular procedure of the school, with the teaching duties of the teachers and will not disrupt regular classes. Furthermore, the EITI was administered by the researcher to three (3) public schools that often experiences heavy flooding. The researcher conducted the administration of task instrument and was observed for about forty five (45) minutes. The school had chosen two (2) sections from Grade 10 students regardless of the section. Moreover, the class who answered the EITI was heterogeneous.

Phase III. Data Analysis

The researcher gathered that task instruments with the responses of the respondents according to their school. Furthermore, the results were collated in order to analyze and determine the students' conceptual understanding on the causes and effects and images of the different concepts on climate change.

Table 10.

Scoring Rubrics for the Students' Conceptual Understanding

Unit Weight (Assigned Values)	***Description***	***Definition***
5	Sound Understanding	The students' response includes all components or some of the scientifically accepted response.
4	Partial Understanding	The students' response may include at least one of the components of the acceptable scientific ideas; and that show understanding of concepts but that may also contain a kind of misconception.
3	Specific Misconception	The students' response may include descriptive, incorrect or illogical information.
2	No Understanding	The students' response is part of, or full form of the question or task; or it may be any irrelevant or uncodable responses; or of a phrase like *"I don't understand."*
1	No Response	The students may have no answer or have the following forms and the likes of responses:*"No answer," "I don't know," "I have no idea."*

Moreover, the students' conceptual understanding on the causes and effects, and images of students on the different concepts of climate were determined using the adapted scoring rubrics that were both revised and adapted from Kozma and Russel (2005). To illustrate the scoring rubrics, Table 10 shows the definition and description as the basis for the students' conceptual understanding. For example, a student with sound understanding which illustrates that students' response includes all components or some of the scientifically accepted response. For instance, the student answer on the effect of increase of temperature to the rate of precipitation must include both natural and man-made causes of increase of temperature. Thus, the effect to the rate of precipitation should not only focus to heavy rainfall but it also it may

cause no rainfall in some areas. But when students have no answer or have responses like I don't know and I have no idea is described as no response.

Table 11.

Scoring Rubrics for the Students' Images

Unit Weight (Assigned Values)	***Description***	***Definition***
5	Reflective and Rhetorical	The students can illustrate the relationship between physical attributes and underlying process and can use one or more representation or images on the climate change.
4	Semantic	The students generate a representation or images on climate change by using formal symbol to represent underlying non-observable processes.
3	Syntactic	The students generate a representation or images on climate change both observed and unobserved physical attributes.
2	Symbolic	The students generate a representation or images on climate change based on physical attributes but include symbols.
1	Depiction	The students generate a representation or images on climate change based on their physical attributes.

On the other hand, Table 11 shows the definition and description for the students' images on the different concepts of climate change. The student is described with reflective and rhetorical images when students can illustrate the relationship between physical attribute and underlying process and can also utilize one or more representation or images in demonstrating the concepts of climate change. For example, for the concept of the increase of global temperature in the formation of rain when there is a presence of low and high temperature, the student can illustrate images that explain formation of rain that both demonstrate the man-made

and natural causes of increase of temperature. But for student with depiction images, can illustrate the concept of formation of rain without demonstrating the factors affecting it.

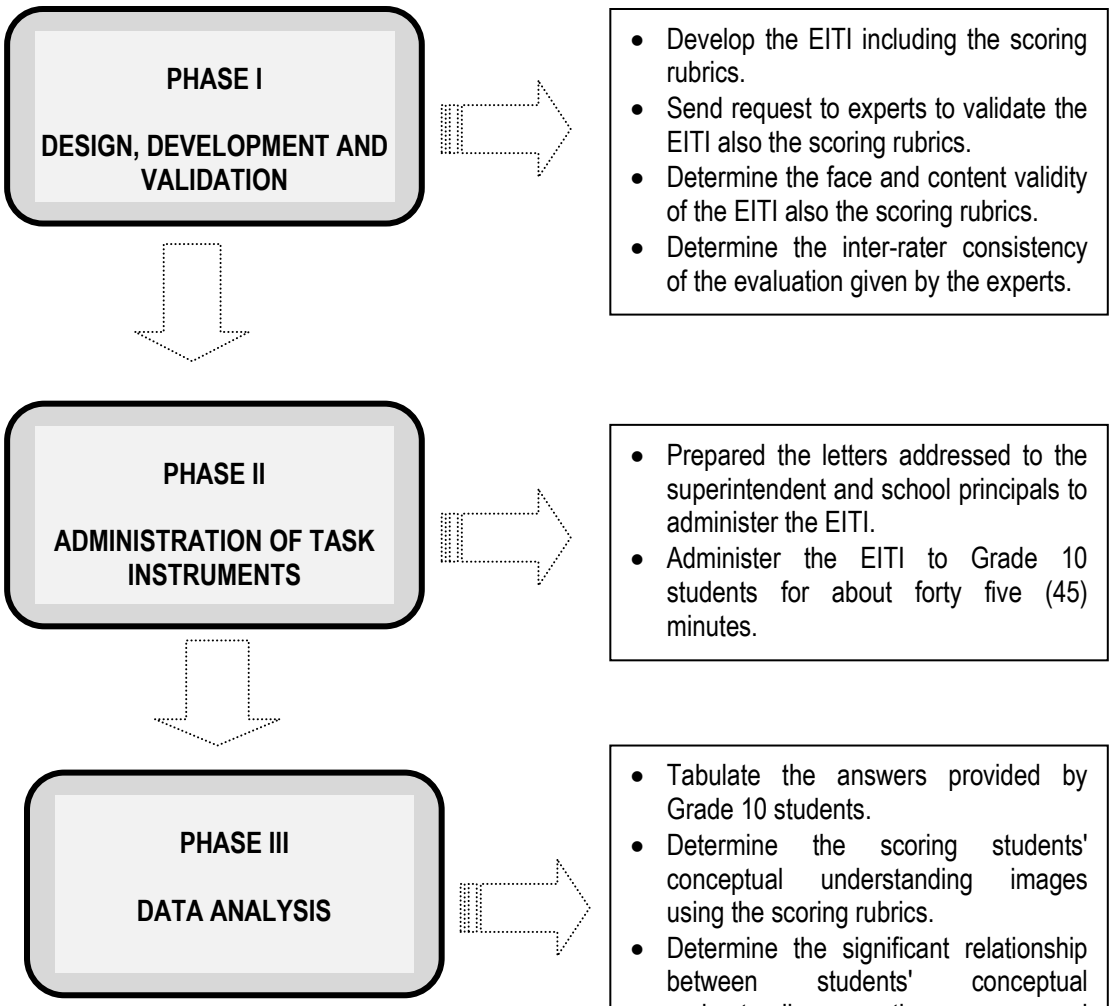


Figure 4. Research Procedure

Figure 4 shows the complete research procedure to attain the objective of the research which is to determine the conceptual understanding and images and also the significant relationship between students' conceptual understanding causes and effects and images on the different concepts of climate change. Furthermore, Figure 4 illustrates the overall procedure of the study starting from the development and validation of the EITI followed by the

administration of the instrument with the approval and endorsement of the Schools Division Office and also with the consent of the school principal and lastly, the data analysis that reveals the students' conceptual understanding and images on the different concepts of climate change. Moreover, determine the significant relationship existing between students' conceptual understanding and images on the concept of climate change.

Statistical Treatment of Data

This section discussed the statistical treatments used to analyze the gathered data of this study. During the validation process Fleiss Kappa was used to determine the inter-rater consistency and the responses of the students were statistically analyzed with the data requirements of the study and descriptive statistics such as frequency, percentage and tables are considered. Furthermore, in order to find out if there is a significant relationship between students' understanding and conceptual images; Pearson (r) Coefficient Correlation Treatment was used.

1. **Mean and Standard Deviation** were used to represent the average and variation of the levels of acceptability of the rating given by evaluators in rating the task instrument and scoring rubrics.
2. **Fleiss Kappa** was used in determining the inter-rater consistency of the evaluation done by the experts. The researcher computed the acceptability of the EITI including the scoring rubrics. Furthermore, to interpret the result of the inter-rater content and face validity of the EITI, the researcher adopted the range and interpretation from Landis and Koch (1977) and was also used by Weiner (2007).

3. **Frequency and Percentage** were used to determine the number of participants in each variable such as:
   a. students' conceptual understanding on the causes and effects on the concepts of climate change and
   b. students' conceptual images on the concepts of climate change.
4. **Pearson's Correlation Coefficient (r) Treatment** was used to determine the relationship of the following variables:
   a. relationship between the students' conceptual understanding on the causes and effects of the different concepts of climate change,
   b. relationship between the students' conceptual understanding on the causes and images of the different concepts of climate change and
   c. relationship between students' conceptual understanding on the effects and images of the different concepts of climate change.

Chapter 4

RESULTS AND DISCUSSION

This chapter presents the results, findings and implications of the students' conceptual understanding and images on the different concepts of climate change. The researcher administered the task instruments to Grade Ten (10) students from three (3) public schools in National Capital Region (NCR) that often experienced heavy flooding when there is heavy rainfall or strong typhoon. The content of the Explain and Illustrate Task Instrument (EITI) were based from the excerpt on news articles and literature from PAGASA, DENR and Climate Change Division. The included climate change concepts in the said instrument are a) temperature, b) rainfall, c) cyclone, d) drought, e) extreme meteorological events and f) greenhouse gases. Likewise, the researcher adapted and modified the scoring rubrics from Kozma and Russel (2005) to describe both students' conceptual understanding and images on the said concepts of climate change. Furthermore, the researcher used the Pearson product-moment correlation to determine if there is an existing significant relationship between students' conceptual understanding of the causes and effects and students' images on the concepts of climate change.

Furthermore, to achieve successful learning in science concepts it is important for teachers to determine what students know and how their ideas are aligned with normative scientific according to Singer, et al., 2012. Hence, the result of this study is to show the students' conceptual understanding and images including the relationship between students' conceptual

understanding and images by illustrating the frequency distribution of students' conceptual understanding and images on the causes and effects of each concept of climate change.

STUDENTS' CONCEPTUAL UNDERSTANDING ON CLIMATE CHANGE

The use of language in learning science is also communicating with science concepts thus, teaching conceptual understanding is a complex endeavor for the science teachers. According to Moran (2015) when there is a deeper conceptual understanding on the concepts of science, the students can also use and apply what they have learned. She also added that the main goal of education is teaching with conceptual understanding. Thus, this research was able to determine the conceptual understanding of students on the different concepts of climate change because current issues on climate change should not be taken for granted.

Furthermore, the students' conceptual understanding on the causes and effects on the different concepts of climate change are summarized in Table 12 and Table 13. Hence, Table 12 is the overall students' conceptual understanding on the causes on the different concepts of climate change while Table 13 is the students' conceptual understanding on the effects on the different concepts of climate change.

It revealed that the students' conceptual understanding on the causes on the concept of temperature has a mean of 3.48 which means that the students have partial understanding on the concept while the rest of the climate change concepts showed that the students have no understanding on the causes of rainfall, cyclone, drought, extreme meteorological condition and greenhouse gases. The results implied that the students need to review on these climate change concepts especially on the concepts of rainfall, cyclone, drought, extreme meteorological condition and greenhouse gases.

Table 12.

Overall Students' Conceptual Understanding on the Causes on the Different Concepts of Climate Change

Climate Change Concepts	$\bar{X}$	***SD***	**Interpretation**
Temperature	3.48	0.993	Partial Understanding
Rainfall	2.33	0.979	No Understanding
Cyclone	2.27	1.167	No Understanding
Drought	2.06	0.998	No Understanding
Extreme Meteorological Condition	2.28	1.445	No Understanding
Greenhouse Gases	2.29	1.359	No Understanding

It also suggests that students may have the understanding on the concepts but did not able to explain the causes behind the phenomenon. For instance, the concept of rainfall abnormalities, the students were not aware on the causes of excessive rainfall but were aware on the effects of above normal rainfall. Also, for the concept of drought and cyclone, the students are described as no understanding but the students are conscious on the effects of drought but contain misconception. The students also are described as no understanding for the concepts of extreme meteorological condition and greenhouse gases but it does not mean that the students have no idea on these concepts. The students might not able to explain the concepts based on scientific explanation especially in relation to what is causing climate change. However, the students should also consider the two factors that affect climate such as natural cause and man-made activities that increase the effect of climate change.

Table 13.

Overall Students' Conceptual Understanding on the Effects of the Different Concepts of Climate Change

Climate Change Concepts	$\bar{X}$	***SD***	**Interpretation**
Temperature	2.05	0.550	No Understanding
Rainfall	2.68	0.724	Specific Misconception
Cyclone	2.61	0.996	Specific Misconception
Drought	2.79	1.425	Specific Misconception
Extreme Meteorological Condition	2.20	1.129	No Understanding
Greenhouse Gases	2.55	1.194	No Understanding

On the other hand, Table 13 revealed that that the students have no understanding on the concepts of temperature, extreme meteorological condition and greenhouse gases. The concept of temperature has a mean of 2.05 and a deviation of 0.550 while the concept of greenhouse gases has a mean of 2.55 and a mean of 1.194 and extreme meteorological condition has a mean of 2.20 and a deviation of 1.129. It revealed that the students need to understand the effects of rainfall, extreme meteorological condition and greenhouse gases that affect the environment. Moreover, the concepts of rainfall, cyclone and drought have specific misconception thus the concept of drought has the highest mean which is 2.79 and a deviation of 1.425 while the concept of rainfall has the lowest mean which is 2.05 and a deviation of 0.550 while the concept of rainfall has a mean of 2.68 and a deviation of 0.724. Hence, the results suggest that students need to review on these concepts in relation to climate change because if students have sound understanding on the different effects of climate change they will also be aware on the causes of

climate change both natural and man-made factors that affect climate. There is a need to talk about climate change thus there is a necessity for the students to review these concepts because it played an important role in understanding the science behind climate change according to Pitpitunge, et al., 2015. Moreover, it can be effective for adaptation and risk management (Barros, et al., 2012; IPCC, 2012).

Concepts on the Cause and Effect of Temperature

Task 1 presents information about PAGASA's estimation that in 2020 and 2050 the Philippines will be warmer and more intense during summer months as reported by Servando (2011). Likewise, it also described the occurrence of ridge of high pressure area (HPA) in the country that causes the increase of average air temperatures as presented by Malano (2016), where the high temperature or a warmer climate increases the rate of evaporation that can result to heavy rainfall and to produce more intense weather condition. The increase of temperature such as the occurrence of El Niño and La Niña that induced drought and flood that affect the agricultural production and supply of potable water. Moreover, Table 14 shows the frequency distribution of students' conceptual understanding on the causes and effects on the concept of temperature.

Table 14 revealed that the students have partial conceptual understanding on the concepts on the causes of increase of temperature which is equivalent to 167 (74.55%) students while there are 21 (9.38%) with specific misconception then 23 (10.27%) students with no response and 13 (5.80%) with no understanding and there are no students who have sound understanding. On the other hand, there are 191 (85.27%) students who have no understanding on the effects of temperature to the rate of precipitation, followed by 16 (7.14%) students with no response and

there are 10 (4.46%) students with partial understanding and there are 7 (3.13%) students with specific misconception but there are no students who have sound understanding on the concept on the effect of temperature.

Table 14.

Frequency Distribution of Students' Conceptual Understanding on the Concept of Temperature

Description	**Causes**			**Effects**		
	f	***%***	***Mean***	***f***	***%***	***Mean***
Sound Understanding	0	0.00%	0	0	0.00%	0
Partial Understanding	167	74.55%	2.98	10	4.46%	0.18
Specific Misconception	21	9.38%	0.28	7	3.13%	0.09
No Understanding	13	5.80%	0.12	191	85.27%	1.71
No Response	23	10.27%	0.10	16	7.14%	0.07
Total	**224**	**100%**	**3.48**	**224**	**100%**	**2.05**

On the other hand, the students' conceptual understanding on the causes has a mean of 3.48 which reveals that the students' conceptual understanding on the causes is in between of specific misconception and partial understanding conceptual understanding while the students' images on the effects has a mean of 2.05 which reveals that the students' images on the effects demonstrate no understanding.

Consequently, below are the examples of students' response with partial understanding on the concept on the possible causes of increase of temperature:

Student 2: *"...burning of fossil fuels, too much cutting of trees, inappropriate waste segregation, too much use of sprays that produces aerosol gas, pollution from the industries, smoke belching and oil spill".*

Student 167: *"... throwing of waste in the river and burning of garbage, smoke from the vehicles".*

Student 193: *"...ozone layer depletion, no more trees, use of nature unresponsively".*

Moreover, the students' response on the concept of deforestation or cutting of trees has scientific basis that it has a contribution to increase the global temperature thus, trees have critical role in absorbing the greenhouse gases that fuel global warming. As a matter of fact, the disappearing forest has increased greenhouse gases penetrating through the atmosphere and has caused the severity of global warming due to irresponsible people using the natural resources of the Earth according to National Geographic, 2016. However, the answers of the respondents are focused on man-made or anthropogenic activities as the major cause of increase of temperature although there are various researches that confirmed that the acceleration of climate change are due to anthropogenic activities according to National Meteorological and Hydrological Services (NMHS) (2013) and was also cited by Rogers, et al., 2013. It also shows that the students have specific misconception such that waste segregation or improper waste disposal which is also an environmental problem but not directly related to the increase of temperature. Furthermore, the students should not disregard the natural causes of increase of temperature such as volcanic eruptions, solar variations, and earth orbital changes.

Consequently, these are also the examples of students with specific misconception on the possible causes of increase of temperature:

Student 39: *"...water pollution".*

Student 58: *"...heat, CO_2, El Niño".*

Student 187: *"...global warming, El Niño".*

Obviously, the students' answers demonstrate misconception that water pollution is the cause of the increase of temperature even though water pollution is an environmental problem but not directly the cause of the increase of temperature while El Niño phenomenon is a natural occurring phenomenon and should not be considered as the primary cause of increase of temperature and El Niño is the result of the abnormal warming the ocean. Furthermore, the students must have included factors such as human-induced activities that increase temperature of the Earth that also contributed global warming.

On the other hand, these are the examples of students' response with no understanding on the causes of increase of temperature:

Student 173: "...*hot water".*

Student 198: *"... shortage of water, pollution and hot temperature".*

Student 217: *"...loss of water and high temperature".*

Although, the students have provided answers on the EITI, but it shows that the students have no understanding or the answers are irrelevant to the concept on how the temperature increases.

Furthermore, these are also the excerpts of students' responses with no understanding on the effects of increase of temperature to the rate of precipitation:

Student 3: *"...acid rain, unexpected migration of animals, clogged garbage, too much carbon dioxide, polluted air and disturbance of aquatic life".*

Student 7: *"...climate change, flash flood, landslide and greenhouse effect".*

Student 65: *"...flood, lack of oxygen, too much carbon dioxide and earth will be damaged".*

Obviously, the respondents' answers are irrelevant or have no understanding to the concept on the possible effects of increase of temperature to the rate of precipitation. The students are referring to the effect of heavy rainfall and other environmental problems such as pollution.

On the other hand, these are also the examples of students' answers that have partial understanding on the effects of increase of temperature to the rate of precipitation:

Student 5: *"...frequent rainfall/storm in tropical regions, north and polar caps continue to melt and increase water level".*

Student 6: *"...destroy earth, abnormalities of the formation of water vapor and heavy rainfall".*

Student 9: "...*heavy rainfall and increase temperature in the surroundings".*

Furthermore, an increase of temperature in the atmosphere will spur more evaporation of water from land and sea that holds more moisture and allows more evaporation that will cause extreme precipitation. Nevertheless, the students' answers demonstrate some concepts that are not related to the rate of precipitation although; the consequence of the increase of temperature is the melting of polar ice caps.

Furthermore, there are students' responses that have specific misconception on the effects of temperature to the rate of precipitation:

Student 12: *"...global warming (unstable status of temperature".*

Student 158: *"... typhoon, flood, warmer temperature that will result El Niño and river will become dry".*

Student 219: *"...pollution, climate change that affect rate of rain".*

Although, the students' answers are referring to some environmental conditions or issues but the answers contain specific misconception such that the concepts on pollution, flood, typhoon, El Niño, etc. are not the effects of increase of temperature to the rate of precipitation

Concepts on the Cause and Effect of Rainfall

Task 2 is referring to the rainfall abnormalities experienced by the Philippines that caused heavy flood in most of the cities in NCR. One example was the heavy rainfall brought by southwest monsoon rain that occurred last August 6-8, 2012 and was also repeated last August 17-21, 2013. It was mentioned by Servando (2011) that PAGASA projected that the annual temperature will increase to about 0.9 ^{o} C to 1.2 ^{o} C for 2020 and 1.7 ^{o} C to 2.2 ^{o} C by 2050. Aside from above normal rainfall, there will be a reduction of rainfall especially during summer season. However, there is likely increase in rainfall during southwest monsoon season in June, July and August until the transition months of September, October and November in most areas of Luzon and Visayas (Tejada, et al., n.d.). Currently, PAGASA has rainfall advisories, classification and measurement to alert the public.

Moreover, it has been reported by World Bank Group (WBG) (2011) that the average precipitation of the Philippines annually is 2,348 mm. Due of its geographical location the country has a wet tropical climate, the annual rainfall is about 1,000 mm in the south to more than 4,000 in mountainous areas specifically along the eastern coast (Asio, et al., 2009). Thus, the frequency distribution of the students' conceptual understanding on the concept of the causes and effects of rainfall in the Philippines are shown in Table 15.

Table 15.

Frequency Distribution of Students' Conceptual Understanding on the Concept of Rainfall

Description	**Causes**			**Effects**		
	f	***%***	***Mean***	***f***	***%***	***Mean***
Sound Understanding	0	0.00%	0	0	0.00%	0
Partial Understanding	20	8.93%	0.36	6	2.68%	0.11
Specific Misconception	99	44.20%	1.33	168	75.00%	2.25
No Understanding	42	18.75%	0.38	22	9.82%	0.20
No Response	63	28.13%	0.28	28	12.50%	0.13
Total	**224**	**100%**	**2.34**	**224**	**100%**	**2.68**

Table 15 revealed that the students' conceptual understanding on the possible causes of increase of excessive or above normal rainfall, such that there are 99 (44.20%) with specific misconception, followed by 63 (28.13%) students with no response then there are 42 (18.75%) students with no understanding followed by 20 (8.93%) students with partial understanding and lastly, there are no students with sound understanding.

On the other hand, the students' conceptual understanding on the effects of increase of heavy rainfall reveals that there are 168 (75.00%) students who have specific misconception, followed by 28 (12.50%) students with no response then, 22 (9.82%) students with no understanding and then, 6 (2.68%) students with partial understanding and there are no students who have sound understanding.

Furthermore, the students' conceptual understanding on the causes has a mean of 2.34 which reveals that the students' conceptual understanding on the causes demonstrate no

understanding while the students' understanding on the effects has a mean of 2.68 which reveal that the students' conceptual understanding on the effects demonstrate no understanding and specific misconception.

Accordingly, these are the examples of students' response that demonstrate specific misconception on the causes of excessive precipitation or above normal rainfall.

Student 16: *"...illegal logging, waste pollution, urbanization, soil erosion, drainage problems and climate change".*

Student 21*:* *"...greenhouse effect".*

Student 221: *"...water pollution".*

Although the students have provided answers related to some climate change concepts but it demonstrates specific misconception on the causes of excessive precipitation or above normal rainfall. On the contrary, the issues on water pollution, drainage problems, soil erosion and greenhouse effects are not the cause of excessive precipitation. However, the students possibly presumed that there is flood during heavy rainfall, but according to Asian Development Bank (ADB) (2012) one cause of flood in urban areas is due to poor management of storm and surface runoff. In addition, the warming planet has resulted extreme precipitation that affect people and countries according to Kreft (2015) and was also cited by Abano (2015).

Furthermore, these are also the examples of students' responses that have no understanding on the causes of excessive precipitation or above normal rainfall:

Student 7: *"...throwing of garbage".*

Student 116: *"...people throw garbage on water and ocean".*

Student 176: *"...throwing of garbage anywhere".*

As a result, the students are aware on the problems on poor waste management; hence, these are not the effects of heavy precipitation or above normal precipitation although, waste disposal is one of the major environmental problems of people living in urban areas.

Furthermore, these are the examples of students' response with partial understanding on the cause of temperature to the rate of precipitation:

Student 92: *"...high temperature in the Pacific Ocean due to climate change".*

Student 64: *"...too much heat in the Pacific Ocean".*

Student 162: *"...near the Pacific Ocean, equator and garbage thrown by irresponsible citizen".*

Correspondingly, the effects of the elevated ocean temperature are the formation of stronger and higher frequency storm such that water evaporates quickly in warmer surface water and making the small ocean storms to escalate into large and stronger according to National Geographic (2016). Also, due to the geographical location of the Philippines, the country has experienced extreme weather condition due to climate change. However, the student has also showed specific misconception on the disposal of garbage.

Furthermore, these are the examples of students' conceptual understanding on the effects of excessive precipitation or above normal rainfall.

Student 65: *"...heavy rainfall and flood".*

Student 167: *"...loss of home and accident".*

Student 179: *"...flood in Metro Manila".*

Obviously, the respondents had possibly associated their personal experiences on flood specially when there is heavy rainfall in urban areas but their answers contain specific misconception such that it is normal for a tropical country like the Philippines to experience

heavy rainfall that result flooding even for just over an hour heavy downpour but of course, one of the unforgettable disasters that occurred in the country was when Typhoon Ondoy made landfall in 2009. It was also mentioned by Lagmay, et al., 2015 that according to Metro Manila Development Authority (MMDA) (2010), the volume of rainwater was not enough to accommodate due to the poor drainage system in urban areas. The students must have included the cause of flood in the Philippines is due to poor waste management, poor drainage system, etc. Also, according to National Wildlife Federation (NWF) (2013) as mentioned by Koslow (2013) that the manifestation of heavy rains and extreme amount of rains in some areas are due to global warming but the students should also remember that flood in the urban areas are not only due to the effect of climate change but also there are some factors that cause heavy flooding especially in urban areas.

Moreover, these are also the examples of students' response that have no understanding on the effects of heavy precipitation.

Student 14: *"...excessive heat during summer".*

Student 109: *"...high temperature of water can absorb the heat of the sea".*

Student 215: *"...water will evaporate after ice melted".*

The students' answers demonstrate that they have no understanding on the concept of the effects of heavy rainfall. Likewise, the respondents are referring to different climate change concepts such as high temperature that increases the rate of evaporation.

As a result these are the students' response with partial understanding on the effects of excessive precipitation or above normal rainfall:

Student 67: *"...heavy rain, typhoon including super typhoons, job and classes suspended".*

Student 71: *"...heavy flooding and storm surge"*.

Student 75: *"...rising sea level, storm surges and heavy flood"*.

It has been noted that the possible effects of rainfall abnormalities or above normal rainfall is storm surge due to super typhoon or heavy rainfall due to habagat. Thus, when a tropical cyclone made landfall it causes storm surge or had rise the still-water sea level (Cuadra, et al., 2014; Longshore, 2008). Aside from experiencing heavy flooding due to excessive rainfall, the students are aware that there are more adverse effects such as storm surge and super typhoon.

Concepts on the Cause and Effect of Cyclone

Task 3 is referring to the tropical cyclones occurred in the Philippines. Climate Change Commission Action Plan for the period 2011-2028 in 2012 had mentioned that the country is considered as the most vulnerable of the occurrence of tropical cyclones while ranked third in terms of people exposed to seasonal events because of its geographical location. The country is also susceptible to the effects of climate change according to Climate Change Vulnerability Index (CCVI) (2015). On the other hand, out of the 16 countries, the Philippines is ranked six (Maplecroft, 2012). Also, Lapus (2008) mentioned that the country is prone to all kinds of hazards because it is strategically located in the path of turbulent and destructive cyclones in the Pacific which is also called as the “Ring of Fire”. There is an average of 100 tropical cyclones are formed every year around the world. Of this total, the bulk is formed in one region which is in the North Pacific Ocean an average of 30 cyclones each year are formed thus moving westward approaching the Philippines according to Philippine Institute for Development Studies (PIDS) (2005). When the tropical cyclone is in the Philippine Area of Responsibility (PAR) is called typhoon and then typhoon exits the PAR then head toward Taiwan, Southern China or

Japan. The impact of occurrence of extreme tropical cyclones is also a manifestation of climate change. Thus, Table 16 shows the frequency distribution of the students' conceptual understanding on the causes and effects of tropical cyclones in the country.

Table 16.

Frequency Distribution of Students' Conceptual Understanding on the Concept of Cyclone

Description	**Causes**			**Effects**		
	f	***%***	***Mean***	***f***	***%***	***Mean***
Sound Understanding	0	0.00%	0	0	0.00%	0
Partial Understanding	38	16.96%	0.68	31	13.84%	0.55
Specific Misconception	76	33.93%	1.02	127	56.70%	1.70
No Understanding	18	8.04%	0.16	13	5.80%	0.12
No Response	92	41.07%	0.41	53	23.66%	0.24
Total	**224**	**100%**	**2.27**	**224**	**100%**	**2.61**

Table 16 shows that there are the 92 (41.07%) students with no response on the causes of increase of number of cyclones followed by 76 (33.93%) students with specific misconception then 38 (16.96%) students with partial understanding while18 (8.04%) with no understanding and there are no students who have sound understanding.

Furthermore, there are 127 (56.70%) students who have specific misconception on the effects of increase in number of cyclones followed by 53 (23.66%) students with no response and there are 31 (13.84%) students with partial understanding and then 13 (5.80%) students with no understanding and there are no students with sound understanding.

On the other hand, the students' conceptual understanding on the causes of cyclone has a mean of 2.27 which reveals that the students' conceptual understanding on the concept on the causes of tropical cyclone demonstrate specific misconception while the students' conceptual understanding on the effects of tropical cyclone has a mean of 2.61 which reveals that the students is in between of no understanding and specific misconception on the effects of tropical cyclone.

From the result, these are the examples of students' response with specific misconception on the possible causes of increase of tropical cyclones in the Philippines.

Student 28: *"...cutting down trees, kaingin system".*

Student 164: *"...strong wind of habagat in the Pacific Ocean".*

Student 158: *"...mining, illegal logging and air pollution".*

The students' answers demonstrate awareness regarding the anthropogenic activities that affect the environment such that cutting trees and air pollution can increase temperature but the students did not give details on how tropical cyclones are formed in the ocean. The students may have included the influence of increase temperature that causes more formation of more tropical cyclones that may landfall specifically in the Philippines that is susceptible to the effect of climate change.

Moreover, there are also students that have partial conceptual understanding on the causes of the increase of tropical cyclone:

Student 146: *"...Philippines is near the Pacific Ocean".*

Student 196: *"...Habagat, Philippines is in the Ring of Fire".*

Student 215: *"...global warming, deforestation and melting of ice in North Pole".*

As shown above, the students are aware on the natural causes of increase in number of tropical cyclones in the ocean such that Philippines has been exposed to natural disasters such as: volcanic eruptions, earthquakes, floods and especially intense tropical cyclones. Moreover, the country has an average of 20 tropical cyclones that enter Philippine waters each year, with eight or nine making landfall (retrieved: http://ecowatch.com/2016/01/22/climate-change-affecting-the-philippines/ on May 14, 2016). Nevertheless, the students may have included that human activities have contributed climate change that possibly cause of the increase of number of tropical cyclones. According to EPA (2010) the formation of tropical cyclone varies its behavior and intensity because of the increasing temperature in the sea surface. Thus, their answers also demonstrate misconception on the concept of deforestation which is another environmental problem.

Results also show that there are students that have no understanding and these are the examples of their response:

Student 1: *"...Milenyo, Yolanda"*.

Student 113: *"...typhoon and stronger typhoon"*.

Student 214: *"...different length of El Niño"*.

Evidently the students' answers demonstrate no understanding on the concepts on the causes of increase of tropical cyclones. Hence, the answers of the respondents are referring to the typhoons that made landfall in the Philippines such as Milenyo and Yolanda while the other concepts are referring to the different environmental problems.

On the other hand, most of the students have specific misconception on the effects of increase in number of tropical cyclones.

Student 88: *"...changing of weather and drought"*.

Student 102: *"...class suspended".*

Student 173: *"...Flood".*

It has been noted that the students' answers on flood and class suspension are the common experiences of people living in the cities. Likewise, urban areas suffered from flood and class suspension even without a typhoon although, the implication in the increase of cyclone activity and intensity is already reaching the cities. According to United Nation (2011) and was also cited by Olago (2013) that there are various effects of tropical cyclones in urban areas such as power outage also called as power blackout that also damage transportation and eventually affect economic activity including supply of potable water. Also, it causes physical destruction of properties that are expensive to repair thus, it also results casualty to humans including wildlife. Furthermore, flood due to typhoon or heavy rainfall can contaminate the water supplies with saltwater, chemicals and waterborne diseases.

Moreover, there are also students that have partial understanding on the effects of increase in number of tropical cyclones:

Student 143: *"...no classes, suspension, high tide, delay of supply, heavy traffic, lack of knowledge and no income".*

Student 181*: "...increase number of typhoons that can destroy home, affect job, and can cause death".*

Student 196: *"...natural resources will be destroyed, no jobs, suspension of classes, economic loss and lifestyle will be hard".*

As a result the responses of students may have related their personal experience such as flood, suspension of classes, etc. specifically in urban areas especially when there is tropical cyclone that made landfall. The formation of stronger storm or tropical cyclones are mostly

developed during summer months thus, the most affected area is the Southeast where storms are formed in the Atlantic Ocean and the Gulf of Mexico according to North Carolina State University (2013).

The result also identified students that have no understanding. Below are the excerpts from the students:

Student 3: *"...loss of water in streams".*

Student 79: *"...increases world temperature".*

Student 120: *"...danger to students and those who are working".*

Therefore, the students' answers demonstrate no understanding on the concept thus, they are referring to different concept but the students' response on danger to students and those who are working is an unclear statement.

Concept on the Cause and Effect of Drought

Task 4 is referring to the El Niño phenomenon that recently the Philippines has experienced. The National Oceanic and Atmospheric Administration (NOAA) (2016) has defined El Niño as unusual warming of ocean temperatures in the Equatorial Pacific while La Niña is the unusual cold ocean temperature. On the other hand, PAGASA (2014) described El Niño as a large scale oceanographic or meteorological phenomenon associated with extreme climatic variability such as rain, winds or drought that is developed in the Pacific Ocean. It is also noted that El Niño occurs in the Pacific basin every two (2) to nine (9) years and usually starts during the northern winter from December to February (De Vera, 2014). But due to the influence of global warming, the mean climate of Pacific Region will probably undergo significant changes due to human-induced or anthropogenic activities.

The warmest year was 2015 which resulted to the strongest El Niño which is due to human induced warming to increase global temperatures (Thompson, 2015). Man-made or anthropogenic activities contributed the effect of global warming but it is also important for students to be aware that El Niño is also a naturally occurring phenomenon. El Niño induces drought has a tremendous impact on the environment including the natural resources thus it delays onset monsoons. When there is drought there is a disruption of the normal human activities such as human and health problems brought by scarcity of water. For proper drought management, knowledge and skill development to better understand the influences of climate variability/extremes particularly drought according to Tejada, et al., n.d. Furthermore, Table 17 shows the frequency distribution of the students' conceptual understanding on the causes and effects on the concept of drought. Thus, Table 17 shows the frequency distribution of the students' conceptual understanding on the causes and effects of drought.

Table 17.

Frequency Distribution of Students' Conceptual Understanding on the Concept of Drought

Description	**Causes**			**Effects**		
	f	***%***	***Mean***	***f***	***%***	***Mean***
Sound Understanding	0	0.00%	0	0	0.00%	0
Partial Understanding	0	0.00%	0.00	123	54.91%	2.20
Specific Misconception	119	53.13%	1.59	16	7.14%	0.21
No Understanding	0	0.00%	0.00	0	0.00%	0.00
No Response	105	46.88%	0.47	85	37.95%	0.38
Total	**224**	**100%**	**2.06**	**224**	**100%**	**2.79**

Table 17 reveals that the students' conceptual understanding on the causes of El Niño resulting to drought and there are 119 (53.13%) students with specific misconception followed by 105 (46.88%) students with no response and there are no students who have sound understanding, partial understanding and no understanding.

Furthermore, there are 123 (54.91%) students that have partial understanding on the effects of drought due to El Niño followed by 85 (37.95%) students with no response and 16 (7.14%) students with specific misconception and there are no students who have sound understanding and no understanding.

On the other hand, the students' conceptual understanding on the causes of drought has a mean of 2.06 which reveals that the students' conceptual understanding has no understanding while the students' conceptual understanding on the effects has a mean of 2.79 which shows that the students' conceptual understanding on the effects is in between of no understanding and has specific misconception on the effects of drought.

As a result, these are the examples of students' response with specific misconception on the causes of El Niño resulting to drought:

Student 13: *"...less rain, no rain".*

Student 25: *"...global warming and climate change".*

Student 50: *"...ozone layer depletion and lesser rain".*

Therefore, it is a common notion of students that El Niño is due to climate change and global warming. Lucero (2016) said that El Niño phenomenon is also a naturally occurring phenomenon. Also, another misconception of students on El Niño phenomenon is no rain, however it also affects rainfall patterns and temperatures such as drought and acute water shortage but the students should bear in mind that it is also causing heavy rains and flooding in

the different part of the world and according to World Health Organization (WHO) (2016) that the risk of El Niño is the increasing Cholera epidemic for instance, in Tanzania.

Furthermore, these are the examples students' response with partial understanding on the effects of El Niño resulting to drought:

Student 95: *"...dying crops, lack of rain and dry soil"*.

Student 97: "*...high temperature*".

Student 144: *"...plants will die, affect the farmers and diseases"*.

Student 200: *"...cannot plant due to dry soil and shortage of water, loss of job"*.

The students' responses show that they are aware of the effects of El Niño in the Philippines. According to Philippine Red Cross in 2016 there are forty two percent (42%) is affected by drought or dry spells due to El Niño but the students are partially aware of the effects of this type of phenomenon because their knowledge may be based on their personal experience of high temperature, lack of rain, etc. like for instance happened last April 17, 2016 that was reported by PAGASA that it was the highest recorded temperature in 2016.

On the other hand, these are examples of students' response that have specific misconception the effects of El Niño resulting to drought:

Student 10: *"...global warming, climate change"*.

Student 12: *"...melting of glaciers in North Pole that caused sea level to rise"*.

Student 123: *"...super typhoon in Tacloban"*.

Accordingly, when Super Typhoon Haiyan also known as Yolanda is also a manifestation of the effects of climate change but the students should also remember that El Niño also happened naturally. Furthermore, there is also an advantage when El Niño occurs because according to Malano, 2015 cited by Macas (2015) that tropical cyclones become erratic because

of El Niño, thus it also brings stronger typhoons. There is also a common misconception of students on the concept of drought that it only brings less rainfall. Drought induced by El Niño can also result heavy rainfall to some areas. The students should also realize that the cause of El Niño is also a natural phenomenon but enhanced because of man-made activities that accelerated climate change.

Concepts on the Cause and Effect of Extreme Meteorological Condition

Task 5 is referring to the occurrence of extreme climatic events like droughts and floods have serious negative implications for major water reservoirs in the Philippines (Jose, et al., 1999). The extreme events are becoming recurrent, intense and unpredictable. The unforgettable super typhoon happened in Tacloban that killed as high as 15,000 cited by Felipe (2015). Moreover, it was recorded as the strongest tropical cyclones. The country's vulnerability to severe weather events such as stronger storms, drought and heavy precipitation will be worsened. Also, Amadore (2005) mentioned that the occurrence of severe El Niño and La Niña and the stronger typhoons and other severe storms in the country are the manifestations of global climate trends.

Another example of extreme events were the tragedies in Legazpi mudslide and the Guinsaugon, Leyte that were triggered by the abnormal increase of rainfall. It was also declared by the Center for Research on the Epidemiology of Disasters as the 2nd and 3rd of the World's Deadliest Disasters of 2006. It killed 2,511 and 800,000 families were affected by these events, respectively (Lapus, 2008). More extreme climatic events provided by PAGASA was the flashflood happened in Cagayan de Oro due to excessive rainfall due to Tropical Storm Sendong (Washi), in December 2011. The vulnerability of the country brought by the extreme

meteorological events has encouraged researchers in order to increase awareness of the effects of climate change especially to students. It is important for the students to understand the concept of extreme meteorological condition to face the battle on climate change.

Moreover, the frequency distribution of students' conceptual understanding on the causes and effects of extreme meteorological condition is illustrated in Table 18.

Table 18.

Frequency Distribution of Students' Conceptual Understanding on the Concept of Extreme Meteorological Condition

Description	**Causes**			**Effects**		
	f	***%***	***Mean***	***f***	***%***	***Mean***
Sound Understanding	0	0.00%	0	0	0.00%	0
Partial Understanding	86	38.39%	1.54	28	12.50%	0.50
Specific Misconception	12	5.36%	0.16	83	37.05%	1.11
No Understanding	1	0.45%	0.01	13	5.80%	0.12
No Response	125	55.80%	0.56	100	44.64%	0.45
Total	**224**	**100%**	**2.27**	**224**	**100%**	**2.17**

Table 18 shows the students' conceptual understanding on the causes of extreme meteorological condition and there are 125 (55.80%) students with no response, followed by 86 (38.39%) students with partial understanding then 12 (5.36%) students with specific misconception and 1 (0.45%) student described as no understanding and there are no students who have sound understanding. Furthermore, the students' conceptual understanding on the effects of extreme meteorological condition thus, there are 100 (44.64%) students with no

response followed by 83 (37.05%) students with specific misconception then 28 (12.50%) students with partial understanding and 13 (5.80%) with no understanding and there are no students who have sound understanding.

On the other hand, the students' conceptual understanding on the causes of extreme meteorological condition has a mean of 2.27 which shows that the students have no understanding while the students' conceptual understanding on the effects has a mean of 2.17 which means that the students have also no understanding on the effects of extreme meteorological condition.

Consequently, the results reveal that these are the examples of students' conceptual understanding with partial understanding on the causes of extreme meteorological condition.

Student 6: *"…climate change, global warming, illegal logging and CFC".*

Student 39*: "...global warming, climate change and greenhouse gases".*

Student 74: *"…CFC, climate change, global warming".*

Therefore, the students have considered that the major cause of extreme meteorological condition is due to man-made activities that contribute global warming and climate change. However, the students' answers contain misconception such that natural causes can also develop extreme phenomenon. Moreover, the concept on greenhouse gases should be not considered as the major causes of climate change but it increases due to anthropogenic activities including natural causes of increase of greenhouse gases in the atmosphere. Thus, life existed because of greenhouse gases that maintained the temperature of the Earth's atmosphere up to 33 ˚C. The greenhouse gases composed of ozone, nitrous oxide, carbon dioxide, water vapor and methane but there is evidence that the increase of greenhouse gases is due to human-induced activities that affect the Earth's temperature. Global warming is considered part of the climate change that

caused changes in precipitation and rise of sea level (Pielke, 2012). It was reported that the increase of frequency and intensity of extreme weather and climatic events can result in unprecedented extreme weather and climate condition (Friends of the Earth (FOE) in 2013.

Moreover, these are the examples of students' answers that have specific misconception on the causes of extreme meteorological condition:

Student 12: *"...excessive heat from the sun"*.

Student 13: *"...improper waste disposal, kaingin system"*.

Student 215: *"...throwing of garbage and rising of water"*.

It clearly shows that the misconception of students on garbage disposal is referring to other environmental problems but not directly the cause of extreme meteorological condition.

Likewise, the prime cause of extreme meteorological conditions is due to the enhanced greenhouse effect due to human-induced activities that increase the amount of greenhouse gases in the atmosphere.

Consequently, these are the examples of responses of students that have specific misconception on the effects of extreme meteorological condition:

Student 70: *"...flood, damage of properties and class suspension"*.

Student 136: "...*flood"*.

Student 178: *"...flood and no more trees"*.

Therefore, the students associated the effects of extreme meteorological condition to flood maybe because of their experience. There are classification of type of hazard or effects such as hydrological, meteorological and climatological disasters according to Emergency Events Database (EM-DAT) (2009) and was also cited by United Nations (UN) (2015).

Moreover, the effect of extreme meteorological condition is significantly different from the average storm.

Moreover, these are the students' response with partial understanding on the effects of extreme meteorological condition.

Student 15: *"...heavy flood, storm surge, loss of properties and lives and business".*

Student 40: *"...stronger typhoons and more typhoons".*

Student 65: *"...super typhoon, cyclone and tornado".*

Student 74: *"...ozone layer depletion, heavy rain, increase in number of typhoons and death".*

Thus, the students have understanding on the effects of this extreme phenomenon such as storm surge, super typhoon but it may also contain a kind of misconception. Like for instance, the concept on ozone layer depletion which is different from global warming. Hence, global warming is caused by the “greenhouse effect" which is enhanced due to man-made (anthropogenic) activities while ozone layer depletion refers to the depletion of an ozone molecule (O_3). Furthermore, the function of the ozone is to protect life on Earth by absorbing most of the ultraviolet (UV) radiation emitted by the sun (Rye, et al., 2001). The results from previous studies demonstrate that students have lack perceptions on ozone layer depletion and global warming on climate and weather (Pitpitunge, 2015; Lombardi and Sinatra 2012; Gowda, et al., 2001). On the other hand, these students are still aware of the effects of climate change even if there are still misconceptions on some concepts associated with extreme meteorological condition.

Concept on the Cause and Effect of Greenhouse Gases

Task 6 is referring to the major greenhouse gases released to the atmosphere through human-induced activities are carbon dioxide, methane, nitrous oxide, and fluorinated gases. Therefore, the increase of greenhouse gas emission has contributed to more warming of climate leading to other changes in the atmosphere, land and oceans around the world according to EPA (2012). Thus, according to Shepardson, et al., 2011 it is important to understand the concept on global warming and climate change. If the students have clear understanding on the concept of global warming and climate change they will also understand the role of greenhouse effect. It is because the Earth's natural greenhouse effect makes life possible. However, man-made activities, such as burning of fossil fuels and destroying forests, have strengthened the natural greenhouse effect, causing global warming. The students should also realize on how to lessen the emission of carbon dioxide that contributes global warming affecting the greenhouse gases. There are many ways on how to lessen carbon footprint even in school or at home. The implication of the lessons they learned in school is when students can put it into real life application.

Furthermore, Table 19 shows the frequency distribution of the students' conceptual understanding on the causes and effects of increase of greenhouse gases accumulation in the atmosphere. It shows the students' conceptual understanding on the causes of accumulation of increase of greenhouse gases and there are 114 (50.89%) students with no response followed by 69 (30.80%) students with partial understanding then 41 (18.30%) students with specific misconception and there are no students who have sound understanding and no understanding.

Furthermore, the students' conceptual understanding on the effects of increase of accumulation of greenhouse gases in the atmosphere and there are 108 (48.21%) without response followed 82

(36.61%) students with specific misconception and 34 (15.18%) with partial understanding and there are no students who are described with sound understanding and no understanding.

Table 19.

Frequency Distribution of Students' Conceptual Understanding on the Concept of Greenhouse Gases

Description	**Causes**			**Effects**		
	f	***%***	***Mean***	***f***	***%***	***Mean***
Sound Understanding	0	0.00%	0	0	0.00%	0
Partial Understanding	69	30.80%	1.23	34	15.18%	0.61
Specific Misconception	41	18.30%	0.55	82	36.61%	1.10
No Understanding	0	0.00%	0.00	0	0.00%	0.00
No Response	114	50.89%	0.51	108	48.21%	0.48
Total	**224**	**100%**	**2.29**	**224**	**100%**	**2.19**

On the other hand, the students' conceptual understanding on the causes of increase of greenhouse gases which has a mean of 2.29 which reveals that the students' conceptual understanding has no understanding while the students' conceptual understanding on the effects of increase of greenhouse gases accumulation has a mean of 2.19 which shows that the students' conceptual understanding of no understanding.

Consequently, these are the examples of students' answers that have partial understanding on the causes and effects of the increase of greenhouse gases:

Student 74: *"...global warming, increasing of temperature, CFC".*

Student 83: *"...factories, pollution and burning of fuels".*

Student 213: *"...cutting down of trees, throwing of garbage in the river and ocean"*.

Accordingly, the increase of greenhouse gases is associated with human activities. Like for instance, carbon dioxide is the major greenhouse gases that increased due to burning of fossils such as natural gas and coal, solid waste, trees and wood products according to IPPC (2007) and was cited by EPA (2012). However, the students should also remember that accumulation of greenhouse gases in the atmosphere is not only due to man-made (anthropogenic) activities but it is also due to natural causes such as volcanic eruptions, ocean current, earth orbital changes and solar variations.

On the other hand, these are the examples of students' conceptual understanding with specific misconception on the causes of increase of greenhouse gases in the atmosphere.

Student 11: "...*excessive heat"*.

Student 55/161: *"...ozone layer depletion"*.

In particular, once the ozone is depleted UV light allows to reach the Earth's surface but this is not an important factor leading to increase of temperature (Buhr, 2008; Madsen, 2007). Thus, climate change and ozone depletion are linked in a number of ways but ozone depletion is not a major cause of increase of greenhouse gases in the atmosphere. It was also cited by Choi (2009) that students' perception that ozone depletion or holes causes global warming. The ozone layer depletion in the stratosphere enhances the greenhouse effect by allowing more solar energy to enter the earth's atmosphere is an example of students' misconception according to Jeffries et al., 2001 and was also cited by Cordero (2007).

On the other hand, these are the students' response with partial understanding on the effects of greenhouse gases in the atmosphere:

Student 15: *"...global warming, climate change, melting of ice in North Pole and South Pole, strong typhoons, ozone layer depletion".*

Student 37: *"...increase of global temperature".*

Student 162: *"...climate change, global warming and ozone layer depletion".*

Furthermore, the increase of greenhouse gas emission resulted global warming. The heat in the Earth's atmosphere is trapped due to the enhanced greenhouse effect caused by human activities. The effects of global warming are stronger typhoons and extreme events, like what happened in Tacloban in 2013, desertification, increase melting of snow and ice and sea level rise (retrieved from: http://whatsyourimpact.org/effects-increased-greenhouse-gas-emissions on June 2, 2016). However, the students should also include that the natural greenhouse effect that makes life possible.

Moreover, there is an implication of understanding to climate change concepts to the students must understand climate as a system and also understand the changes to the system due to natural and human influences according to Shepardson, et al., 2012. Also, Pitpitunge, et al., 2015 mentioned that sciences behind the concept of climate change and impact could increase understanding on the importance of climate change adaptations.

On the other hand, the use of image used in teaching scientific knowledge is like understanding the reality and the role of image in teaching and learning of science concepts with visual (Torrecilla, 2013). She also added that the use of image can influence and can stimulate when it comes to the concepts related to climate change and it can raise awareness of climate change impacts with a view of influencing behavior change (Conniff, et al., 2016). In addition, the constructivist perspective, the learners can construct their own learning such that they can create their own images in relation to science the concepts.

STUDENTS' IMAGES ON THE CONCEPTS OF CLIMATE CHANGE

Table 20 reveals that students' images are described as depiction which means the students can generate image based on the physical attribute. The concept of temperature has a mean of 1.49 and the lowest mean is 1.13 on the concept of drought. Thus, it demonstrates that students' images should be determined by the science teacher in order for them to identify how the students are learning the science concepts.

Table 20.

Overall Students' Images on the Different Concepts of Climate Change

Climate Change Concepts	$\bar{X}$	***SD***	**Interpretation**
Temperature	1.49	0.501	Depiction
Rainfall	1.17	0.432	Depiction
Cyclone	1.34	0.476	Depiction
Drought	1.13	0.413	Depiction
Extreme Meteorological Condition	1.44	0.497	Depiction
Greenhouse Gases	1.43	0.659	Depiction

Students' Images on the Concept of Temperature

Task 1 is referring to the role of temperature to the formation of rain. According to EPA (2016) that as temperature rises and the air becomes warmer, more moisture evaporates from land and water into the atmosphere. Heavy downpours are due to more water vapor in the atmosphere, also in other countries it will result more rain and snow. Thus, the unforgettable experience of the people in Tacloban that rainfall has increased by 257% from 1998 to 2011.

(Retrieved from http://www.rappler.com/nation/48599-six-ways-climate-change-affects-ph-cities on June 4, 2016).

Table 21.

Frequency and Distribution on Students' Images on the Concept of Temperature

Description	***f***	***%***	***Mean***
Reflective and Rhetorical	0	0.00%	0.00
Semantic	0	0.00%	0.00
Syntactic	0	0.00%	0.00
Symbolic	110	49.11%	0.98
Depiction	114	50.89%	0.51
Total	**224**	**100%**	**1.49**

Furthermore, Table 21 shows the students' images on the concept of temperature and there are 114 (50.89%) students who have a depiction image followed 110 (49.11%) students who have symbolic image and there are no students who are syntactic, semantic and reflective and rhetorical images. On the other hand, the students' image on the concept of temperature has a mean of 1.49 which reveals that the students' image is described as depiction which means the students generate image based on the physical attribute only.

Moreover, Figures 5a and 5b are the examples of students' images that are described as depiction and were illustrated by Student 29 and Student 62. The illustration shows that the

students' representation or images in the formation of rain in the presence of temperature is depicted by creating images such as the clouds and raindrops, respectively.

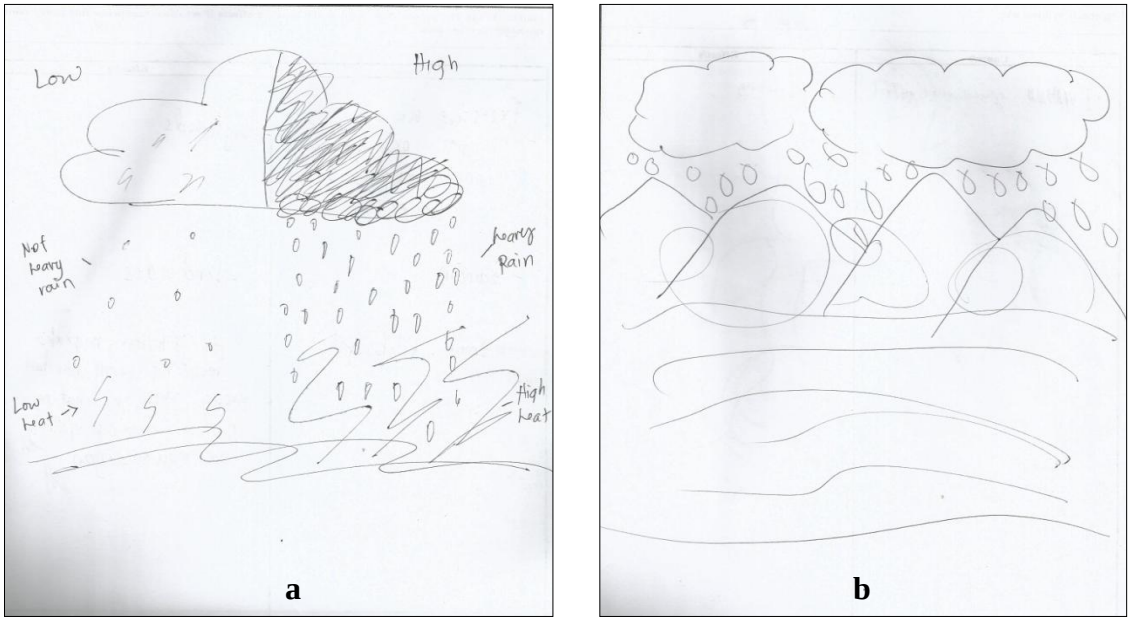


Figure 5a and 5b. Sample of depiction images on the concept of temperature

Although the students illustrated the images on the concept of temperature but they failed to demonstrate the effect of temperature to the rate of rainfall. The students should have included factors affecting increase of temperature such as the natural and man-made causes affecting the formation of rain. The students also did not illustrate the complete cycle of water cycle process. Also, when there is an increase of temperature there will be more evaporation thus result heavy downpour.

On the other hand, there are also students who are symbolic, which means the students generate an image symbolizing the concept of formation of rain illustrating the water cycle. The students illustrated the water cycle by using arrows signifying evaporation of water which resulted to rain but the students did not able to demonstrate the factors affecting the formation of

rain when there is a presence of low and high temperature. The students should also have included natural and man-made factors that caused increase of temperature which resulted to climate change. In fact, the increase of temperature causes heavy rainfall and drought in some areas. The students have the idea on the process of water cycle with the influence of the increase of temperature but they need to expand their knowledge aside from illustrating the process of formation of rain. It would be easier for the students to demonstrate the effects if they know the causes of the increase of temperature which affects rainfall. Figures 6a and 6b are the examples of students' conceptual images that are described as symbolic, illustrated by Student 3 and Student 5. In this case, the students have used arrows as representation of the processes precipitation and evaporation with downward and upward directions, respectively. The images demonstrate evaporation of an upward arrow direction which means during evaporation a liquid substance will become gas according to National Geographic Society (2016).

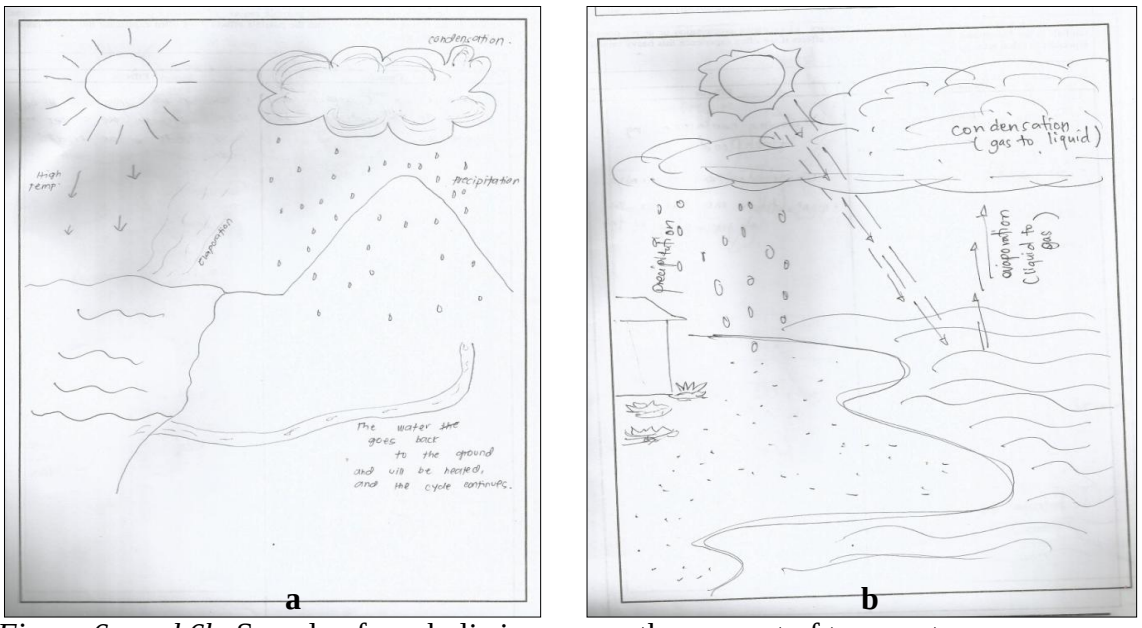


Figure 6a and 6b. Sample of symbolic images on the concept of temperature

The behavior of the molecules when heated will vibrate and move quickly and escapes into the atmosphere and turns into water vapor. Whenever there is an increase of temperature it also increases evaporation according to the study of Centre for Ecology and Hydrology (CEH) (2013). In order to stress the importance of understanding water cycle in order for the students to picture out how it alter the formation of rain due to climate change.

Students' Images on the Concept of Rainfall

Task 2 is referring to the rainfall abnormalities that are evident in the Philippines. An example of rainfall abnormality when typhoon Typhoon Ondoy "*Ketsana"* rainfall reaches 455 millimeters within 24 hours while Habagat in 2012 has higher rainfall reaches 472 millimeters (*retrieved from http://www.rappler.com/newsbreak/39948-by-the-numbers-ondoy-habagat-2012-2013on May 19, 2016).* There were areas submerged in flood at record-breaking levels like Metro Manila also destroyed infrastructure and agriculture according to Olan (2014). The devastation caused by Typhoon Ondoy had realized people to be prepared for a strong typhoon that frequently visited the Philippines. Another event was the flashflood and landslide happened in Davao Oriental, Compostela Valley due to the excessive rainfall and severe winds due to Typhoon Pablo in December 2012 that had 1067 deaths (Esquivel, 2016). The occurrence of rainfall abnormalities is a manifestation that climate is changing abruptly that brings numerous changes to the planet and also the organisms. Mohan and Ingber (n.d) from the National Geographic mentioned that there are validated records around the world that global temperature has increased to one degree Celsius which is almost two degrees Fahrenheit during the second half century. Thus, a rainfall abnormality is also the effect of increase of temperature.

Moreover, Table 22 shows the frequency distribution of students' images on the concept of rainfall. It reveals that the students' images on the difference of Southwest Monsoon "Habagat" and Northeast Monsoon "Amihan" and the possible causes of heavy precipitation in the Philippines and there are 191 (85.27%) students who are described as with depiction image followed by 31 (13.84%) students who are symbolic and then 1 (0.45%) students who are syntactic and semantic and there are no students who are reflective and rhetorical.

Table 22.

Frequency and Distribution on Students' Images on the Concept of Rainfall

Description	***f***	***%***	***Mean***
Reflective and Rhetorical	0	0.00%	0
Semantic	1	0.45%	0.02
Syntactic	1	0.45%	0.01
Symbolic	31	13.84%	0.28
Depiction	191	85.27%	0.85
Total	**224**	**100%**	**1.16**

Furthermore, the students' image on the concept of rainfall has a mean of 1.16 which reveals that the students' image is described as depiction. Thus, Figures 7a and 7b are examples of students' images that are described as depiction. It is noted that the common image or representation of students on the concept of Southwest Monsoon "Habagat" is linked to heavy rainfall that caused flooding while the concept on Northeast Monsoon "Amihan" brings cold

weather. Student 38 and Student 155 had illustrated the difference between Northwest Monsoon "Amihan" and Southwest Monsoon "Habagat" including the possible effects of heavy rainfall or excessive precipitation.

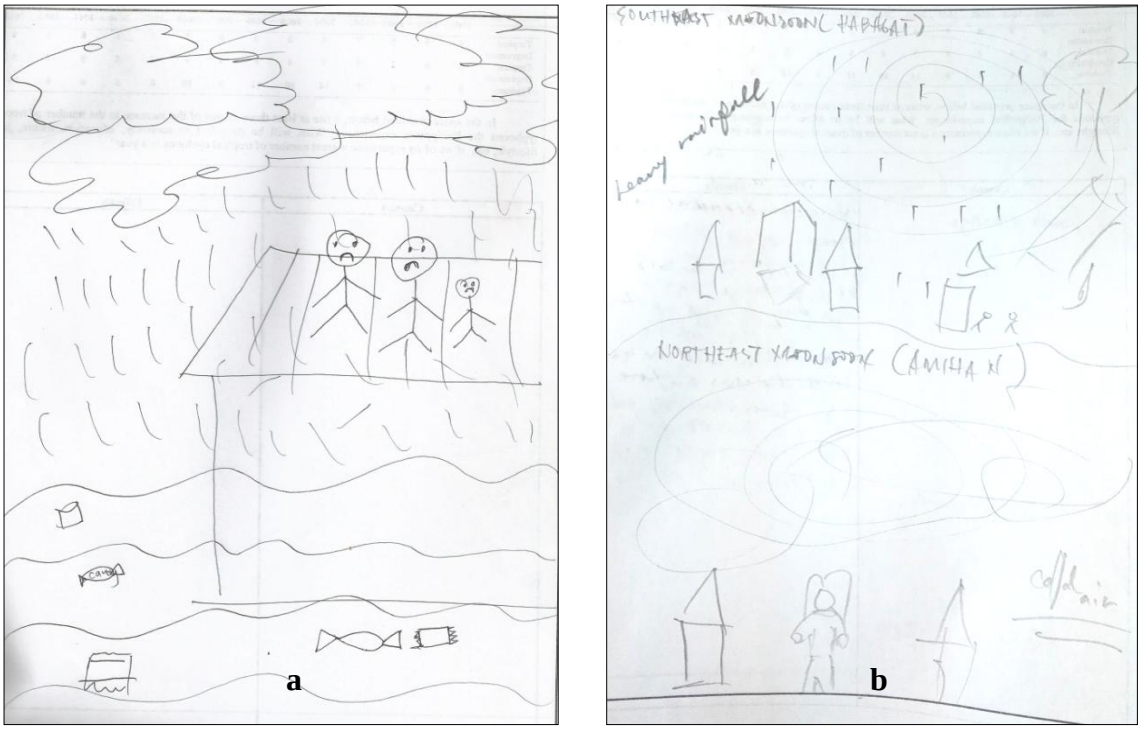


Figure 7a and 7b. Sample of depiction images on the concept of rainfall

On the other hand, there are also students who are symbolic which means the students generate a representation or image on the concept of rainfall based on physical attributes but includes symbols. The use of symbols is significant for the teachers and students because it can save time and simultaneously to be able to communicate effectively according to Abbott, et al., 2015 and was also cited by Kambouri (2015). Figures 8a and 8b are examples of students' images that are described symbolic. Hence, the map of the Philippines is a representation on the development of northeast monsoon "amihan" and southwest monsoon "habagat". Although, these are naturally occurring phenomenon the respondents have also demonstrated the effects of man-made (anthropogenic) activities (e.g. pollution due to smoke from vehicles).

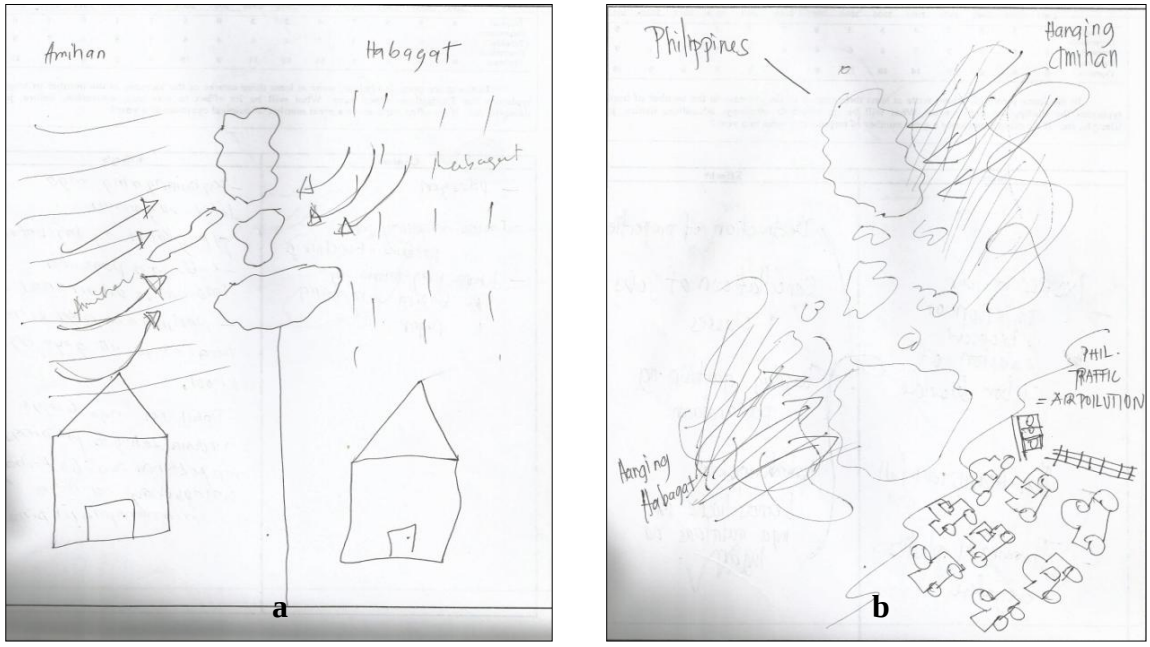


Figure 8a and 8b. Sample of symbolic students' images on the concept of rainfall

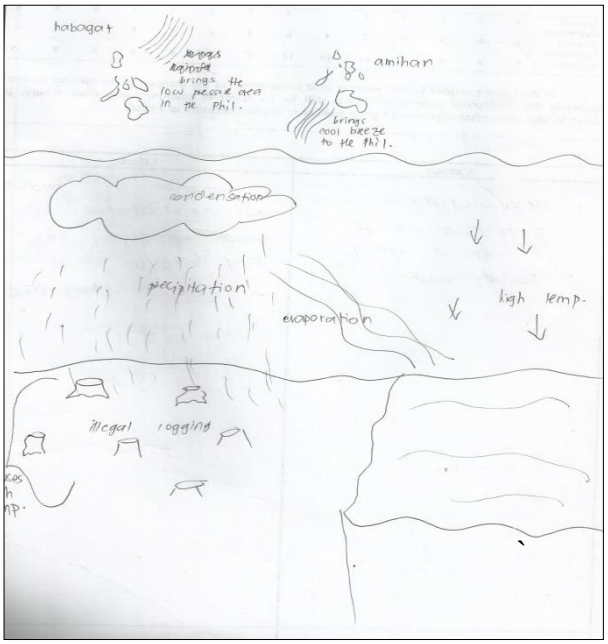


Figure 9. Sample of syntactic image on the concept of rainfall

Moreover, there are also students who are syntactic which means the students can generate a representation or images both observed and unobserved physical attributes. Thus, the

students demonstrate the concept on rainfall specifically northeast monsoon "amihan" and southwest monsoon "habagat". Furthermore, Figure 9 is an example of syntactic image, illustrated by student 3. The student compared the difference between Habagat and Amihan and has also demonstrated the effect of the man-made or anthropogenic activities (e.g. cutting down of trees). The student has also showed the concept of evaporation of water when high temperature is present that will result to heavy rainfall. Lastly, Figure 10 is an illustration from Student 39. This is an example of an image which is semantic which means the student can generate a representation or image on the concept of rainfall by using formal symbol to represent underlying non-observable processes.

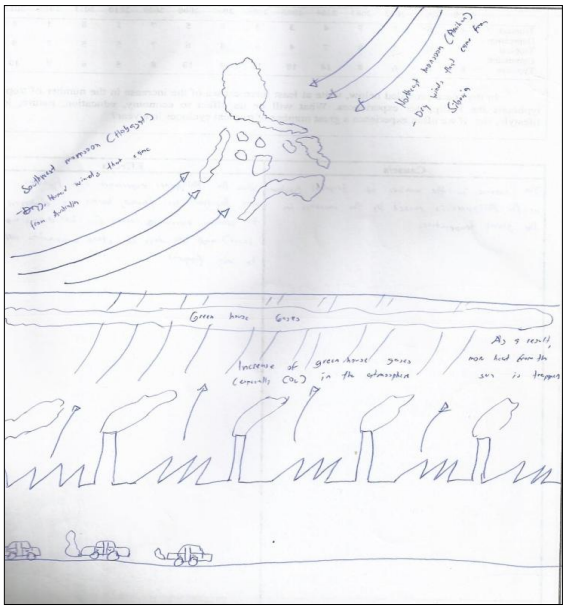


Figure 10. Sample of a semantic image on the concept of rainfall

Thus, Figure 10 is an example of semantic image emphasizing the effects of human-made or anthropogenic activities (e.g. harmful gases from factories) released to the atmosphere that increases the amount of greenhouse gases such as carbon dioxide (CO_2). It is also noticeable, that formal symbol or chemical of symbol of carbon dioxide (CO_2) was used by the student to

indicate that there is an increase of carbon dioxide (CO_2) due to man-made or anthropogenic activities.

Students' Images on the Concept of Cyclone

Task 3 is referring to the tropical cyclones that occurred in the Philippines. According to National Hurricane Center (n.d.) the estimated tropical cyclones that are developed is about 100 annually. Thus, the specific location where tropical cyclones is in the western North Pacific ocean and each year an average of 30 cyclones are moving westward approaching the Philippines and tropical cyclone is called typhoon once it enters the Philippine Area of Responsibility (PAR). Thus, according to PAGASA (2016) the oceans and seas which played an important role on the weather of continental masses. The solar energy is reaching the sea-surface and is expended in the process of evaporation. The water evaporated from the sea/ocean and then carried up into the atmosphere and condenses then forming the clouds from which all forms of precipitation and when cyclonic circulations occur it is called tropical cyclones (retrieved from http://pagasa.dost.gov.ph/index.php/tropical-cyclone-information on August 2, 2016).

Table 23 shows the frequency distribution of students' images on the concept of cyclones. It reveals the students' images on the concept of formation of tropical cyclones in the Pacific Ocean and also the possible causes of stronger typhoons in the Philippines and there are 148 (66.07%) students who are described as depiction image followed 76 (33.93%) students who are symbolic and there are no students who are syntactic, semantic and reflective or rhetorical. Furthermore, the students' image on the concept of cyclone has a mean of 1.34 which reveals that the students' images are described as depiction.

Table 23.

Frequency and Distribution of Students' Images on the Concept of Cyclone

Description	*f*	*%*	*Mean*
Reflective and Rhetorical	0	0.00%	0
Semantic	0	0.00%	0
Syntactic	0	0.00%	0
Symbolic	76	33.93%	0.67
Depiction	148	66.07%	0.66
Total	**224**	**100%**	**1.34**

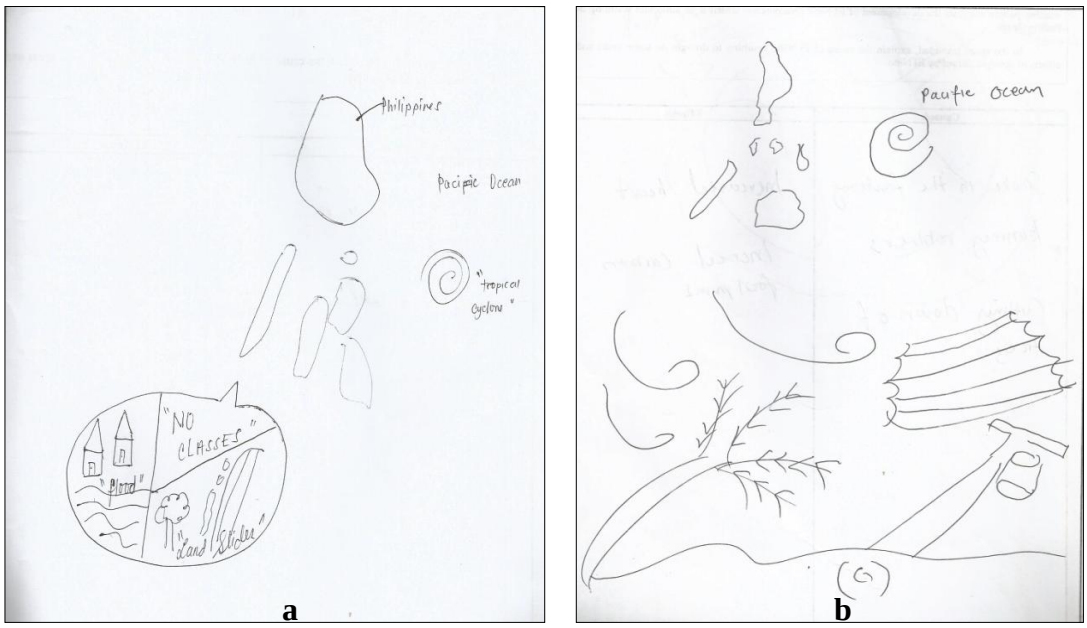


Figure 11a and 11b. Sample of depiction students' images on the concept of cyclones

Thus, students have illustrated an example of depiction image that are illustrated by Student 8 and Student 46 on the concept of formation of tropical cyclone including the possible causes of stronger typhoon which is shown in Figures 11a and 11b. Obviously, the images

demonstrated by these students had experienced the effect of tropical cyclone or typhoon in the Philippines but the students were not able to illustrate the process of how tropical cyclone is formed but it affect the environment.

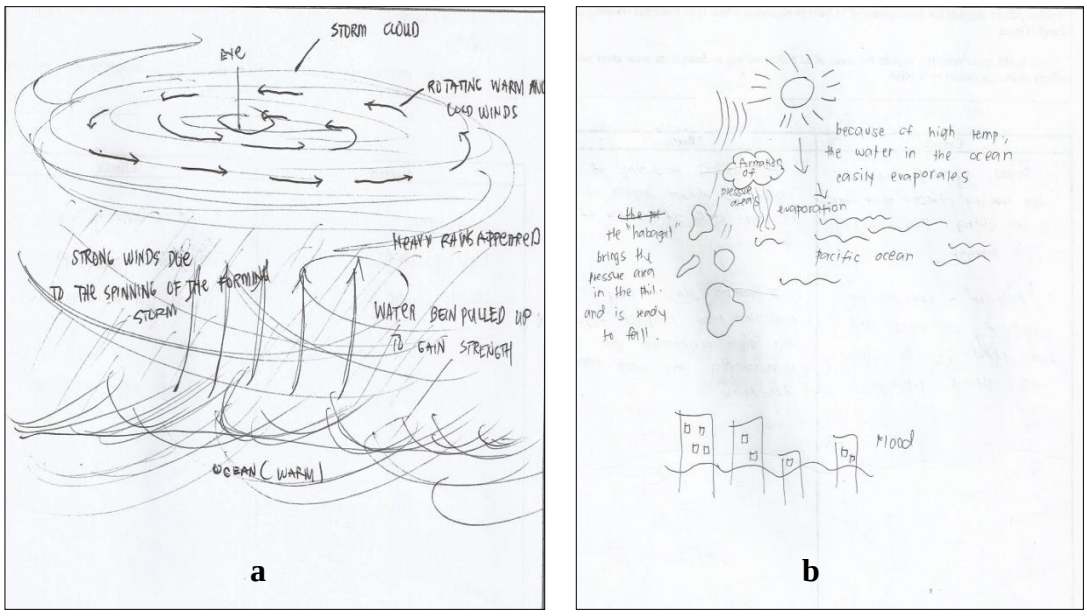


Figure 12a and 12b. Sample of symbolic students' images on the concept of cyclones

Also, Figures 12a and 12b below are the illustration of Student 3 and 4 that are described as symbolic. Thus, the students had used symbols such as arrows signifying evaporation, precipitation and the formation of tropical cyclone in the Pacific Ocean.

Students' Images on the Concept of Drought

Task 4 is referring to the concept of El Niño-Southern Oscillation (ENSO) that is a naturally occurring phenomenon that involves fluctuating ocean temperatures in the equatorial Pacific region cited by NC State University (n.d.). Although, it is a naturally occurring phenomenon there are some man-made activities that enhanced the effect of global warming. Currently, climatologists are still estimating whether this year's El Niño is the biggest on record.

According to Pearce , 2016 that it was forecasted by Cai in 2014 that there will be three (3) "Super-El Niño" on Earth of just three decades in 1982-83, 1997-98, and 2015-16 according to Australia's National Science Agency (CSIRO) (2016).

Table 24 shows the frequency distribution on the students' images on the concept of drought. It shows that student' images on the concept of the development of El Niño in the Pacific Ocean, resulting in drought and there are 201 (89.73%) students who are described as depiction image followed 19 (8.48%) students who are symbolic then 4 (1.79%) students who are syntactic and there are no students who are semantic and reflective and rhetorical. Moreover, the students' image on the concept of drought has a mean of 1.12 which reveals that the students' images are described as depiction.

Table 24.

Frequency and Distribution on the Students' Images on the Concept of Drought

Description	***f***	***%***	***Mean***
Reflective and Rhetorical	0	0.00%	0
Semantic	0	0.00%	0
Syntactic	4	1.79%	0.05
Symbolic	19	8.48%	0.17
Depiction	201	89.73%	0.90
Total	**224**	**100%**	**1.12**

Thus, there are students who have a depiction image. Figures 13a and 13b below are the examples of an illustration of Student 62 and Student 65 which are described as depiction. Furthermore, the illustration shows that the students are aware on the effects of El Niño drought such as affecting the agricultural, environmental, health, economic and social consequences but the students did not illustrate the development of El Niño in the ocean. In addition, man-made activities must have been included in the illustration that also caused extreme El Niño and the scientists are now working to understand if global warming will lead to more powerful El Niño's that will make droughts and floods more intense. Moreover, this year's El Niño is generating extreme weather condition according to Pearce, 2016.

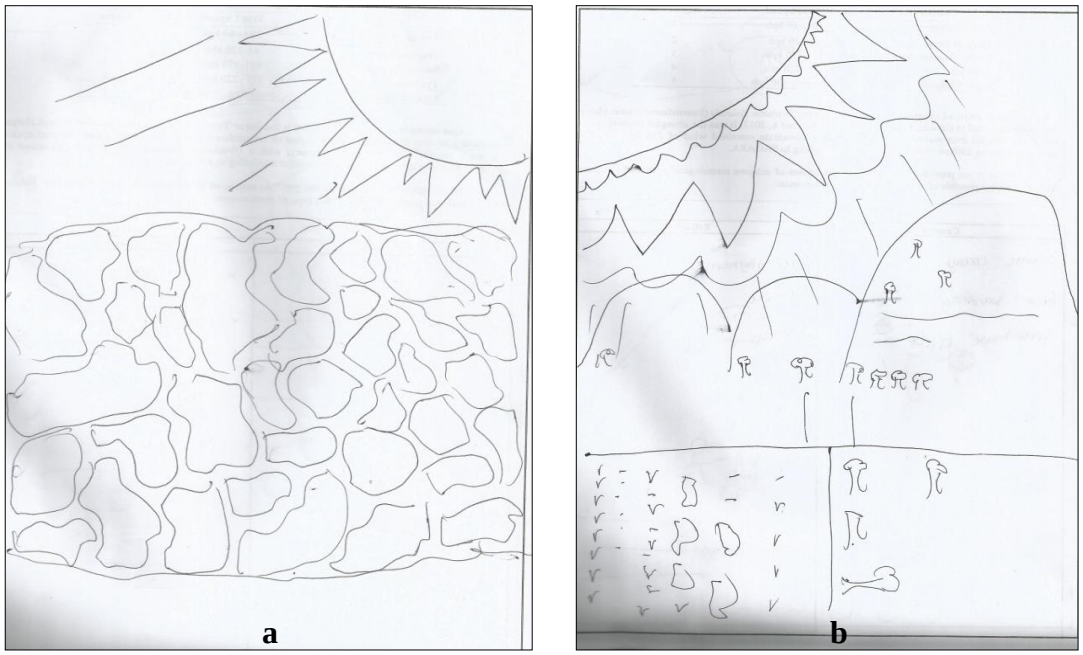


Figure 13a and 13b. Sample of a students' depiction images on the concept of drought

On the other hand, there are also students who are described as symbolic image. Thus, Figures 14a and 14b below are the examples of representation or images illustrated by Student

35 and Student 37. The students demonstrated the use of symbols such as arrows and map that signifying movement and direction, respectively.

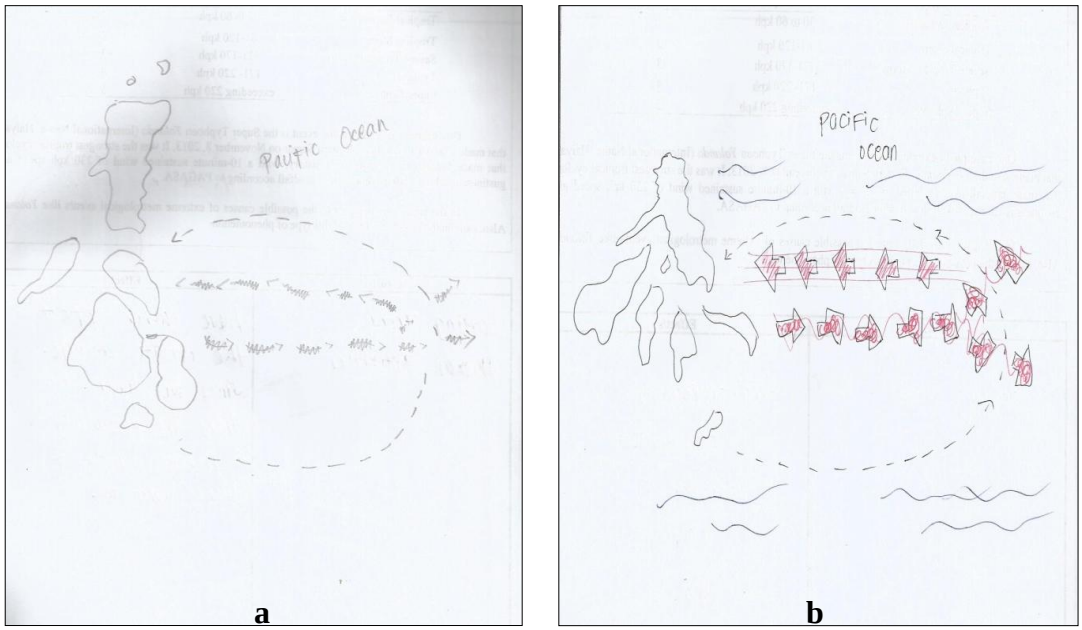


Figure 14a and 14b. Sample of symbolic images on the concept of drought

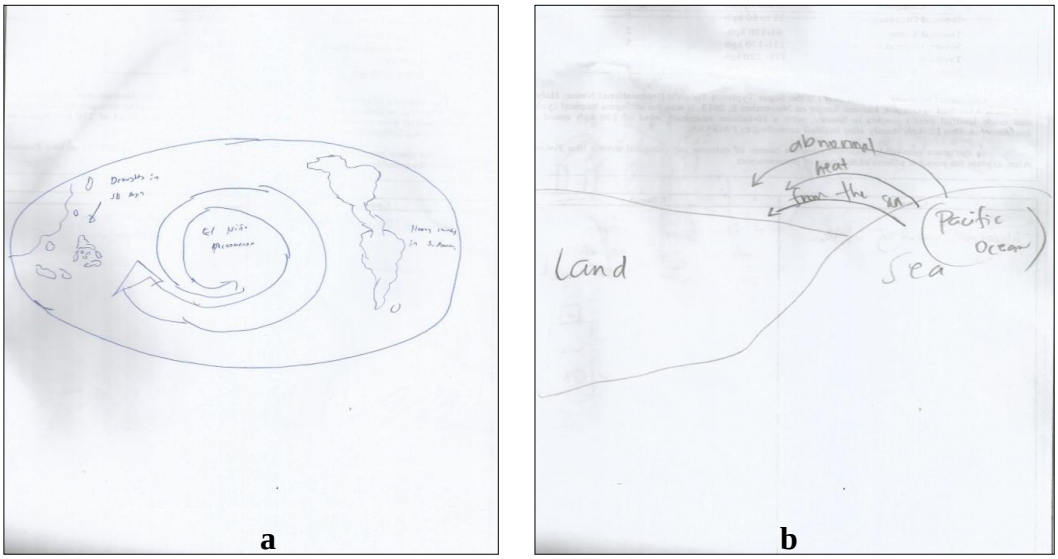


Figure 15a and 15b. Sample of syntactic images on the concept of drought

Also, Figures 15a and 15b are the examples of syntactic images which demonstrated an idea on how the El Niño is formed in the ocean. It shows that the students have an idea that tropical cyclones are formed in the ocean.

Students' Images on Extreme Meteorological Condition

Task 5 is referring to extreme meteorological events that are recently happening. It is also an indication that the climate has warmed such that hot days hotter, severe droughts and rainfall and flooding becomes heavier according to NWF (2016). The major changes in the atmosphere which is associated to climate where there is rapid increase of hot days and severe meteorological events. Sea levels also started to rise as an effect of a regression of the polar ice packs coupled with a decrease in pH due to the effects of increasing carbon dioxide (CO2) in the ocean. Also, it led to water deprivation in some areas (Amato, et al., 2015). Thus, Table 25 shows the frequency distribution on students' images on the concept of extreme meteorological condition.

It shows the students' images on the concept of man-made (anthropogenic) activities on the possible causes of extreme meteorological events and there are 126 (56.25%) students who have a depiction images followed by 98 (43.75%) students who are symbolic and there are no students who are syntactic, semantic and reflective and rhetorical images. On the other hand, the students' image has a mean of 1.44 which reveals that the students' images are described as depiction.

Table 25.

Frequency and Distribution of Students' Images on the Concept of Extreme Meteorological Condition

Description	*f*	*%*	*Mean*
Reflective and Rhetorical	0	0.00%	0
Semantic	0	0.00%	0.00
Syntactic	0	0.00%	0.00
Symbolic	98	43.75%	0.88
Depiction	126	56.25%	0.56
Total	**224**	**100%**	**1.44**

Figure 16a and 16b. Sample of depiction images on the concept of extreme meteorological condition

Therefore, Figures 16a and 16b are the examples of students' illustration on concept of causes of extreme meteorological events due to man-made or anthropogenic activities that are described as depiction. Consequently, the students demonstrated cutting of trees as human activities that affect the climate illustrated by Student 3 and Student 61.

On the other hand, Figures 17a and 17b are examples of students' illustration and images on the concept of causes of extreme meteorological events due to man-made (anthropogenic) activities that are described as symbolic. Student 41 and Student 43 illustrated other factors involving man-made activities such as demonstrating smoke belching that is also harmful in the environment.

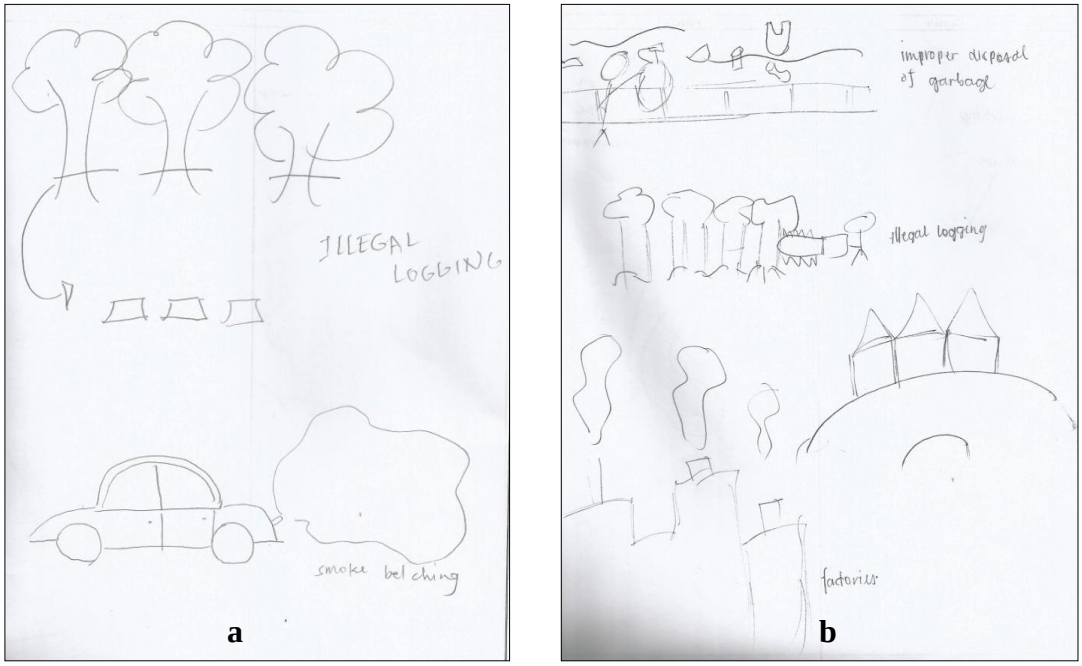


Figure 17a and 17b. Sample of symbolic images on the concept of extreme meteorological condition

Students' Images on the Concept of Greenhouse Gases

Task 6 is referring to the concept of increase of accumulation of greenhouse gases in the atmosphere due to man-made activities. According to Turnbull (2015) if human activities will continue emitting harmful gases in the atmosphere if will create catastrophic consequences such as rising of sea levels, shortage of water and more heat waves and fire. According to Lee, et al., 2007 the greenhouse effect is a natural phenomenon but it was intensified which means it is accelerated due to human activity.

Moreover, Table 26 shows the frequency distribution of students' images on the concept of greenhouse gases.

Table 26.

Frequency and Distribution of Students' Images on the Concept of Greenhouse Gases

Description	***f***	***%***	***Mean***
Reflective and Rhetorical	0	0.00%	0.00
Semantic	0	0.00%	0.00
Syntactic	21	9.38%	0.28
Symbolic	54	24.11%	0.48
Depiction	149	66.52%	0.67
Total	**224**	**100%**	**1.43**

Table 26 shows the students' conceptual images on the concept of greenhouse gases and there are 149 (66.52%) students who have depiction images followed by 54 (24.11%) students

who are symbolic and there are 21 (9.38%) students who are syntactic but there are no students who are in semantic and reflective and rhetorical. Furthermore, the students' image on the concept of greenhouse gases has a mean of 1.43 which reveals that the students' images are described as depiction. It means that the students generate an image based on the physical attribute. Furthermore, Figures 18a and 18b are the examples of Student 31 and Student 65 are examples of depiction image that illustrates the concept of ozone layer depletion.

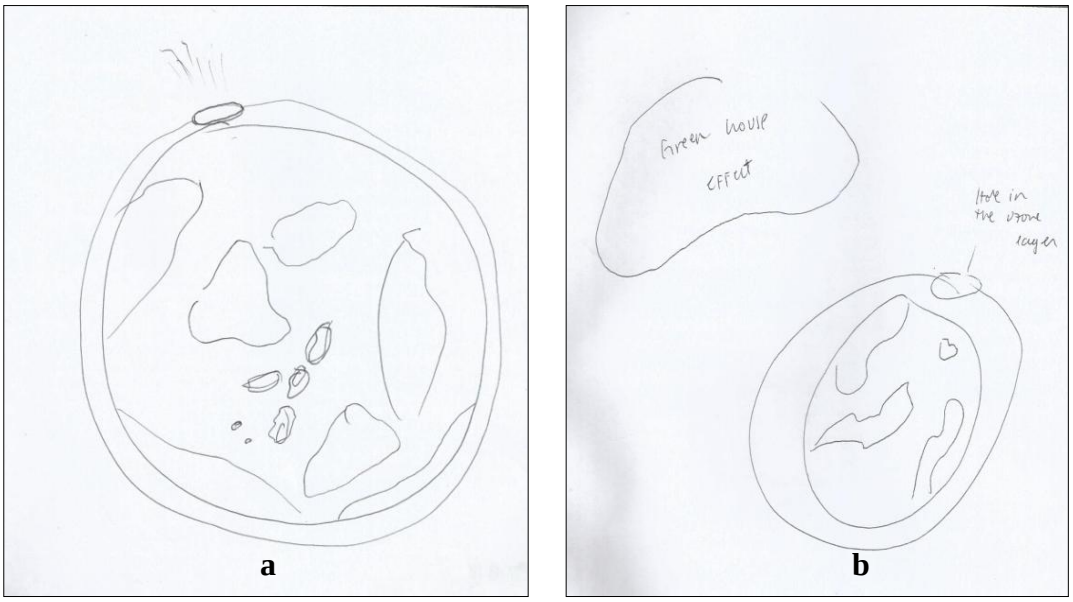


Figure 18a and 18b. Sample of depiction images on the concept of greenhouse gases

While Figures 19a and 19b are the examples of students' images that are symbolic thus, the students had used arrows in as a representation of the releasing harmful gases to the atmosphere.

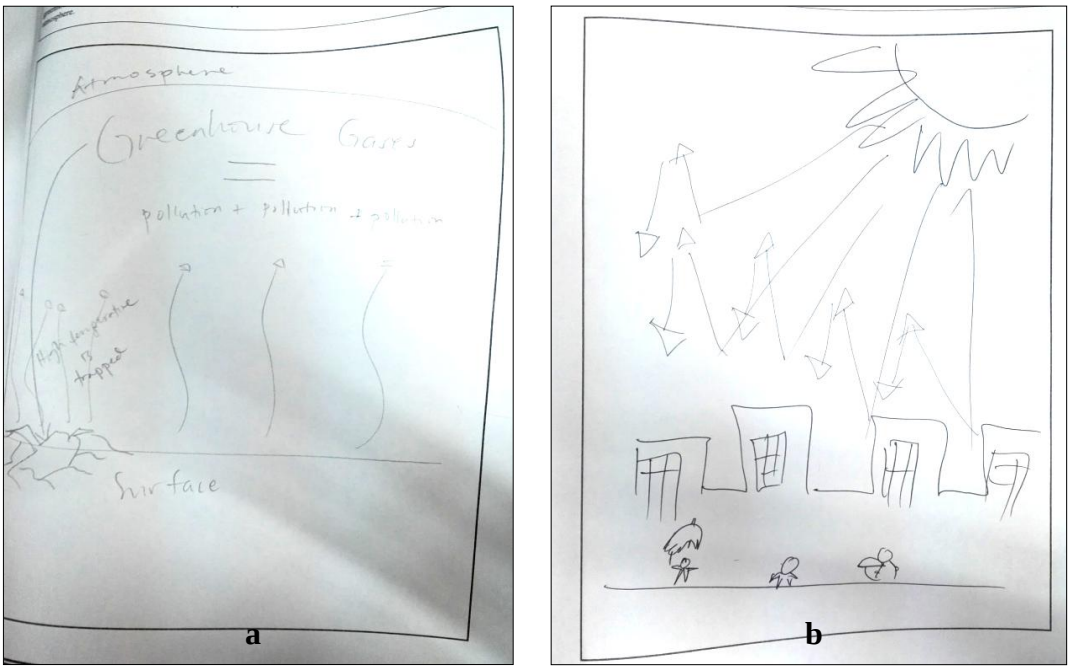


Figure 19a and 19b. Sample of symbolic images on the concept of greenhouse gases

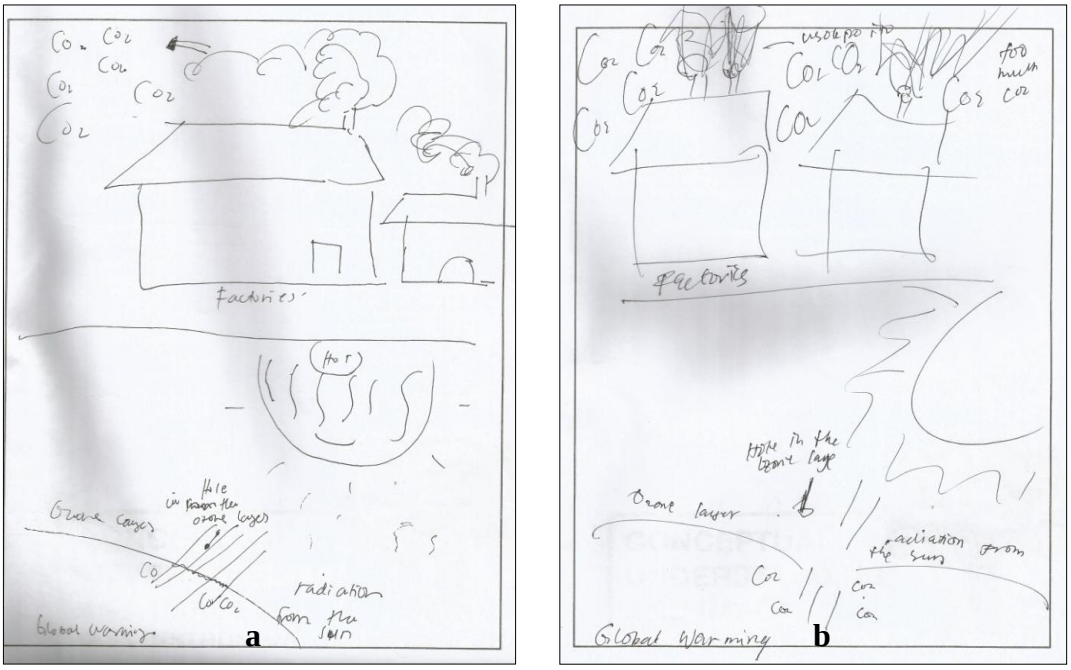


Figure 20a and 20b. Sample of syntactic images on the concept of greenhouse gases

Furthermore, Figures 20a and 20b are the examples of students' conceptual images that are syntactic image since the students had used formal symbol of CO_2 which is the chemical

formula of carbon dioxide and the students were trying to illustrate the increase of carbon dioxide in the atmosphere due to human-induced activities.

Moreover, the students' images encouraged students to formulate their own questions in a constructivist perspective and nowadays memorizing facts and concepts is not the most important skill (Yilmaz, 2007; Yılmaz and Huyuguzel Cavas 2006; Caprio 1994; Staver, 1998). Thus, this research determines the students' images on the different concepts of climate change. Moreover, the results demonstrate that there is a significant relationship between students' conceptual understanding and images on the different concepts of climate change.

Significant Relationship Existing Between the Students' Conceptual Understanding and Image on the Different Concepts of Climate Change

On the other hand, the researcher also determines the existing relationship between students' conceptual understanding and images on the different concepts of climate change. To find out the relationship Pearson's Correlation Coefficient (r) Treatment was used and the guidelines of the interpretation of values are illustrated on Table 27 below.

It shows the interpretation of the computed Pearson (r) adapted from Evans (1996) that suggests the absolute value of r. This will be the basis for the interpretation of determining the significant relationship between students' conceptual understanding on the causes and effects and images of students on the different concept of climate change. The values of r, that is, when r is 0.80-1.0 indicate that there is a very strong positive relationship. However, if r is 0-0.19, there is a very weak positive relationship. Moreover, the results of the relationship between students' conceptual understanding on the causes and effects and students' images on the different concepts of climate change are tabulated for further discuss the results. Table 28 shows the

existing relationship between students' images and conceptual understanding on the cause and effect on the concept of temperature.

Table 27.

Pearson's (r) Correlation Coefficient Treatment

Values	Interpretation
0.00- 0.19	very weak and positive relationship
0.20 - 0.39	weak and positive relationship
0.40 - 0.59	moderate and positive relationship
0.60 - 0.79	strong and positive relationship
0.80 – 1.00	very strong and positive relationship

Furthermore, the students' conceptual understanding on the causes of increase of temperature and images have a very weak significant and positive relationship which is equivalent to 0.112 Pearson (r) while the conceptual understanding on the causes and effects have a weak significant and positive relationship which is equivalent to 0.240 Pearson (r) same with conceptual understanding on the effects and images which is equivalent to 0.279 Pearson (r). It demonstrates that the students' conceptual understanding on the causes and effects have weak significant relationship which means that the students may be knowledgeable on the causes of increase of temperature but not aware on the effects of the increase of temperature to the rate of precipitation.

Table 28.

Significant Relationship Existing Between Students' Images and Conceptual Understanding on the Cause and Effect on the Concept of Temperature

Concept on Temperature	(r)	Interpretation
Conceptual Understanding on the Causes and Effects	**0.240**	weak and positive relationship
Conceptual Understanding on the Causes and Images	**0.112**	very weak and positive relationship
Conceptual Understanding on the Effects and Images	**0.279**	weak and positive relationship

Table 29.

Significant Relationship Existing Between Students' Images and Conceptual Understanding on the Cause and Effect on the Concept of Rainfall

Concept on Rainfall	(r)	Interpretation
Conceptual Understanding on the Causes and Effects	**0.349**	weak and positive relationship
Conceptual Understanding on the Causes and Images	**0.141**	very weak and positive relationship
Conceptual Understanding on the Effects and Images	**0.032**	very weak and significant positive relationship

Table 29 shows the students' conceptual understanding on the causes of rainfall abnormalities or above normal rainfall and effects has a weak and positive relationship which has a Pearson (r) of 0.349 while the causes and images have a very weak and positive relationship

which has a Pearson (r) of 0.141 also with the conceptual understanding on the effects and images have a very weak and positive relationship which has Pearson (r) of 0.032.

It demonstrates that the students are aware on the effects above normal rainfall but may not be aware on the causes of excessive precipitation. There is also a very weak significant relationship between conceptual understanding on the causes-images and effects-images, thus there are students who can explain the concept easily by writing the causes and effects than by creating images or vice versa.

Table 30.

Significant Relationship Existing Between Students' Images and Conceptual Understanding on the Cause and Effect on the Concept of Cyclone

Concept on Cyclone	(r)	Interpretation
Conceptual Understanding on the Causes and Effects	**0.610**	strong and positive relationship
Conceptual Understanding on the Causes and Images	**0.310**	weak and positive relationship
Conceptual Understanding on the Effects and Images	**0.194**	very weak and positive relationship

Table 30 shows the students' conceptual understanding on the causes of the increase in number of cyclone and its effects have a strong and significant positive relationship which has a Pearson (r) of 0.610 while the students' conceptual understanding on the causes and images have a weak and significant positive relationship which has a Pearson (r) of 0.310 the same with students' conceptual understanding on the effects and images has a Pearson (r) of 0.194.

Furthermore, the students' conceptual understanding on the causes of increase number of tropical cyclones and its effects has strong significant positive relationship because the students were able to give the effects of tropical cyclones especially in the Philippines although the students did not explain further the concept of formation of tropical cyclones. On the other hand, there is a weak significant positive relationship between students' causes-images and effects-images because there are students who can express their ideas by creating images than by writing the concepts.

Table 31.

Significant Relationship Existing Between Students' Images and Conceptual Understanding on the Cause and Effect on the Concept of Drought

Concept on Drought	(r)	Interpretation
Conceptual Understanding on the Causes and Effects	**0.552**	moderate and positive relationship
Conceptual Understanding on the Causes and Images	**0.145**	very weak and positive relationship
Conceptual Understanding on the Effects and Images	**0.109**	very weak and positive relationship

Moreover, Table 31 shows the students' conceptual understanding of the causes of El Niño resulting in drought and its effect has a moderate and positive relationship which has a Pearson (r) of 0.552 while the students' conceptual understanding on the causes and images has a very weak and positive relationship also with students' conceptual understanding on the causes

and images which has Pearson (r) of 0.145 same with students' conceptual understanding on the effects and images which has a 0.109 Pearson (r).

Furthermore, the moderate significant positive relationship between the students' conceptual understanding on the causes and effects, thus the students are aware of the effects of drought even if did not able to explain further the causes of El Niño that resulted to drought.

On the other hand, the students' conceptual understanding on the causes-images and effects-images have a very weak significant relationship because students did not able to illustrate on how El Niño is formed that resulted to drought. The images they had created demonstrated only the effects of drought but not the cause affecting drought that includes natural and man-made causes of drought. The students may be aware of the effects but failed to create an image on how it is formed. If the students are aware on the causes of drought they can also illustrate the effects brought by El Niño including the natural phenomenon that happened in the Pacific Ocean. The students perhaps illustrated the images on the effects of drought maybe because they experienced the extreme temperature and news spread by media. It also help students realized the value of taking care of their environment if they are aware on the causes and effects of drought. There are students also who are good in illustrating their ideas instead of verbalizing it.

Table 32 shows the students' conceptual understanding on the causes and effects of extreme meteorological condition which have a strong and positive relationship which has a Pearson (r) of 0.746. On the other hand, the students' conceptual understanding on the causes and images has a Pearson (r) of 0.532 and students' conceptual understanding on the effects and images has a Pearson (r) of 0.452 which has a moderate and positive relationship.

Table 32.

Significant Relationship Existing Between Students' Images and Conceptual Understanding on the Cause and Effect on the Concept of Extreme Meteorological Condition

Concept on Extreme Meteorological Condition	(r)	Interpretation
Conceptual Understanding on the Causes and Effects	**0.746**	strong and positive relationship
Conceptual Understanding on the Causes and Images	**0.532**	moderate and positive relationship
Conceptual Understanding on the Effects and Images	**0.452**	moderate and positive relationship

Furthermore, there is a direct relationship between students' conceptual understanding on the causes and effects because it can be that the students have no understanding on both causes and effects on the concept of extreme meteorological condition also with the students' conceptual understanding on the causes and images and students' effects and images.

Table 33 reveals the students' images and conceptual understanding on the cause and effect on the concept of greenhouse gases has a strong and positive significant relationship which has a Pearson (r) of 0.792 which means that the students' conceptual understanding on the causes and effects are directly proportional. Thus, when the students' conceptual understanding on the causes increases the conceptual understanding on the effect also increases and vice versa.

Table 33.

Significant Relationship Existing Between Students' Images and Conceptual Understanding on the Cause and Effect on the Concept of Greenhouse Gases

Concept on Greenhouse Gases	(r)	Interpretation
Conceptual Understanding on the Causes and Effects	**0.792**	strong and positive relationship
Conceptual Understanding on the Causes and Images	**0.441**	moderate and positive relationship
Conceptual Understanding on the Effects and Images	**0.496**	moderate and positive relationship

On the other hand, the students' conceptual understanding on the causes and images have a moderate and positive relationship which has a Pearson (r) of 0.441 same with conceptual understanding on the effects and images which has a Pearson (r) of 0.496. The results demonstrate that students' conceptual understanding and the images have moderate significant relationship.

Implications of the Study

The results revealed that the students' conceptual understanding on the different concepts of climate change thus, students have partial understanding on the causes of increase of temperature while the rest of the selected climate change concepts, the students have no understanding on the concepts of rainfall, cyclone, drought, extreme meteorological condition, and greenhouse gases. On the other hand, the students' conceptual understanding on the effects of temperature, extreme meteorological condition and greenhouse gases have no understanding

while the concepts of rainfall, cyclone and drought have specific misconception. Thus, the results suggested that there is a necessity for the students to review these concepts because it played an important role in understanding the science behind climate change according to Pitpitunge, et al., 2015. Also, it can be effective for adaptation and risk management (Barros, et al., 2012; IPCC, 2012).

Moreover, the students' images results were described as depiction which means the students generate an image or representation based on the physical attribute of the different concepts of climate change. It was mentioned by Kress, et al., 2001; Alerby, 2000 that the students' written words and drawings are conceptual visualizations or representations of their understandings. The students' images also suggested that they are mutually constitutive with the students' conceptual understanding (Coppola, et al., 2008).

The researcher also found out some misconceptions on the different climate change concepts. Campbell (2009) cited that Piaget (1968) disagreed with the tabula rasa notion of the child's mind instead he proposed that young children gradually develop cognitive structures to make sense of the world. The students have constructed informal theories about how things work by the time the child enters school. Therefore, it is important for the science teachers to determine the conceptual understanding and images of students on the different concepts of climate change. Also, when science teachers determine their misconceptions they can have an opportunity to educate themselves and to provide accurate information. For instance, the misconception of students on the concept of greenhouse gases such that ozone layer depletion led to some students to be mistakenly conclude that aerosols sprays, which did contribute to ozone depletion, thus contribute to global climate change (Fitzgerald, et al., 2015). There were students also believed that holes in the ozone layer will cause an enhanced greenhouse effect

which was also observed by Mason and Santi, 1998; Dove, 1998; Anderson and Wallin 2000). Students considered that energy released (not the carbon dioxide) from cars is the reason of global warming (Boyes and Stanisstreet, 1997). Moreover, the students also considered waste disposal as the cause of climate change. However, the teacher should explain the appropriate way of waste disposal.

Climate change literacy is regarded as an important skill and also knowledge (Giroux, 2010). She also added that knowledge can influence the students to interact with the environment at the same time understanding scientific news in every decision they made. Also, Korsager (2015) emphasized the importance of preparedness of the students for the future climate change and work for sustainable development that science education shall comprise education for sustainable development thus, it requires scientific knowledge which is more relevant and realistic. The advantage of enhancing students' understanding on climate change issues can be more personally relevant. Furthermore, research revealed that students are found out to be less anxious about climate change. In effect, the sense of responsibility of students to provide solutions and the optimism to reduce the impact of climate change are low (Aguja, et al., 2015). Also, it can boost students' knowledge by determining their current knowledge (Carr, et al., 2015) because it can provide science teachers to create possible teaching strategies to integrate the concept on climate change while teaching science. More importantly, the students will also be aware about mitigation and adaptation concepts especially if they are aware on the causes and effects on the concepts on climate change.

Moreover, in the Philippines there is a necessity for an intensive research and more information sources for better understanding of quality education especially in science curriculum. Hence, the result of this research will provide science educators with sufficient

evidence to give them information that can be used for the development of appropriate long-term strategies not only for the science teachers. This is also in support for the existing policy framework on Education for Sustainable Development (ESD) and Climate Change Education (CCE) which is likely to be able to achieve its goal with the help of a concrete research according to Shaw, et al., 2014. On the other hand, the United Nations Educational, Scientific and Cultural Organization (UNESCO) (2007) emphasized that education and raising awareness play an essential role in increasing the climate change adaptation and mitigation capabilities of communities by enabling individuals to make informed decisions. Thus, education helps the learners understand the causes and consequences of climate change, prepares the students to live with impacts of climate change. Preparing the battle of the changing climate is due to the geographical location of the Philippines which is prone to disasters, hence, the problem on climate change is not easy problem to fix but every Filipino should try especially the younger generation and the first step is educating citizens both in the Philippines and around the world (retrieved from http://ecowatch.com/2016/01/22/climate-change-affecting-the-philippines on April 29, 2016). Moreover, Philippines has fewer published research about determining the students' understanding and images on the concept on climate change. This study can also support the K to 12 Senior High School Disaster Readiness and Risk Reduction that currently discussed the basic concept of hazards on earthquake, volcano, geological such as hydro meteorological hazards which include typhoon and El Niño.

Chapter 5

SUMMARY, CONCLUSION AND RECOMMENDATION

This research aimed to determine the students' conceptual understanding and images on the different concepts on climate change using the developed EITI. Moreover, it is also to determine the significant relationship between students' conceptual understanding and images on the following concepts: temperature, rainfall, cyclone, drought, extreme meteorological condition and greenhouse gases. Thus, this chapter will present the summary of the findings and conclusion. The recommendations are also presented for further improvement of the study.

Summary of Findings

The results of students' conceptual understanding on the causes-and-effects and images on the concepts of climate change namely: a) temperature, b) rainfall, c) cyclone, d) drought, e) extreme meteorological condition, and e) greenhouse gases and also the result on the significant relationship of students' conceptual understanding and images.

Students' Conceptual Understanding on the Causes of the Different Concepts of Climate Change

The researcher found out the students' conceptual understanding on the causes of the different concepts of climate change. Thus, the concept of temperature has a mean of 3.48 which means that the students had partial understanding thus, responses of the students may include at least one of the components of the acceptable scientific ideas that show understanding but may

also contain a kind of misconception on the concept of temperature and it has a deviation of 0.993. On the other hand, the rest of the concepts specifically on rainfall, cyclone, drought, extreme meteorological condition and greenhouse gases were interpreted as no understanding which means that the students' response is irrelevant or uncodable response also with response like "I don't understand".

Students' Conceptual Understanding on the Effects of the Different Concepts of Climate Change

On the other hand, the researcher also found out the students' conceptual understanding on the effects of the different concepts of climate change. Thus, the students had specific misconception on the concept of drought which has a mean of 2.79 with deviation of 1.425 then the concept of rainfall which has a mean of 2.68 with deviation of 0.724 while the concept of cyclone has a mean of 2.61 with deviation of 0.996. Furthermore, results revealed that students had no understanding on the concept of greenhouse gases which has a mean of 2.19 with deviation of 1.194 then extreme meteorological condition has a mean of 2.15 with deviation of 1.129 then the concept of temperature has a mean of 2.05 with deviation of 0.550.

Significant Relationship Between Students' Conceptual Understanding on the Causes and Effects and Conceptual Images on the Concepts of Climate Change

Furthermore, results revealed that the concepts of cyclone, extreme meteorological condition and greenhouse gases had a strong significant relationship which means that the students' conceptual understanding on the causes and effects were strongly related. Like for instance, if a student has a partial understanding on the causes, it also has a partial understanding

on the effects and if a student has no understanding on the causes it is most likely a student has no understanding on the effects. On the other hand, the concept of drought had moderate and significant relationship which means that the students' conceptual understanding on the causes and effects were also closely related. The results revealed that the students' conceptual understanding on the causes of drought had specific misconception while the effects of drought demonstrated partial understanding. Thus, the results suggest that the students' conceptual understanding on the causes and effects of drought both needs improvement because results suggest that the students had partial understanding on the causes of increase of temperature and had a specific misconception on the effects of drought. Moreover, the students' conceptual understanding on the causes and effects on the concepts of temperature and rainfall had a weak significant relationship. Based on the results the students had partial understanding on the causes of increase of temperature but no understanding on the effects of temperature. Also, the students had no understanding on the causes of above normal rainfall but had specific misconception on its effects.

Additionally, the significant relationship between students' conceptual understanding on the causes and images had a moderate positive relationship on the concepts of extreme meteorological condition and greenhouse gases. For instance, the students cannot explain and illustrate the concepts of extreme meteorological condition and greenhouse gases or the students can explain and illustrate the concepts of extreme meteorological condition and greenhouse gases. Based on the result, the students had no understanding on causes and effects of extreme meteorological condition as well as the greenhouse gases and the images were both described as depiction. Moreover, the concept of cyclone had a weak significant relationship which means that students' conceptual understanding on the causes of cyclone is also related to the image

illustrated by the students. The results revealed that the students had no understanding on the causes while the students' images were described as depiction. Furthermore, the results also showed the significant relationship between the students' conceptual understanding on the causes and images on the concept of temperature, rainfall and drought had a very weak significant which means that the students can either explain the concept of climate change but cannot illustrate the concept or the other way around. There are students who can express their ideas by using visualization.

Furthermore, the researcher also found out the significant relationship between the students' conceptual understanding on the effects and images thus, there were moderate significant relationship between the students' conceptual understanding on the concepts of extreme meteorological condition and greenhouse gases. The students had no understanding on the effects and their images were described as depiction. On the other hand, the concept of temperature had weak significant relationship because students had no understanding on the effects but their images were also described as depiction. On the other hand, the concepts of rainfall, cyclone and drought had a very weak significant relationship. It means that the students may not explain the effects of the different concepts mentioned in this study but they can illustrate properly the concept to convey message. For instance, students can explain the effect of drought but cannot illustrate images pertaining to the effects of drought caused by El Niño phenomenon.

Conclusion

In the light of the foregoing findings, the following conclusions were drawn to answer the following specific questions:

1. **What are the students' conceptual understanding of the causes and effects of the different concepts of climate change?**

Consequently, the study revealed that the students' conceptual understanding on the causes-and-effects on the concepts of rainfall, cyclone, drought, extreme meteorological condition, and greenhouse gases revealed that the students had no understanding. Likewise, the students had partial understanding on the causes of temperature. On the other hand, the students' conceptual understanding on the effects on the concepts of temperature, extreme meteorological condition and greenhouse gases were described as no understanding while students' conceptual understanding on effects on the concepts of rainfall, cyclone and drought revealed specific misconception.

2. **What are the students' images on the different concepts of climate change?**

Based on the result of the study, the students' images revealed that students were described as depiction. It is when students generate an image or representation based on the physical attribute of the different concepts climate change which is shown in Table 20. The concept of temperature has the highest mean which is 1.49 while the concept which has the least mean is the concept of drought which is equivalent to 1.13.

3. **Are there significant relationship existing students' conceptual understanding and images on the different concepts of climate change?**

Consequently, the results revealed that students need to enhance their conceptual understanding and images on the different concepts on climate change especially on the

concept of cyclone, extreme meteorological condition, and greenhouse gases which had a strong significant relationship on the conceptual understanding on the causes and effects but the concept of extreme meteorological condition and greenhouse gases had a moderate significant relationship. On the other hand, there was moderate significant relationship between effects and images on the concept of extreme meteorological condition and greenhouse gases.

Recommendations

To further improve the research, the researcher is recommending the following for succeeding studies in relation to this research:

1. To use another group of independent respondents to verify the veracity of the results to other demographic variables such as age, sex, socio-economic status and year level of the present study on conceptual understanding and images on climate change,
2. To come up of an EITI version using a vernacular translation for the future respondents to have an easy understanding on the context of the task,
3. To conduct interview on selected respondents to further triangulate their responses and illustrations on the task instrument,
4. To cover other related concepts of climate change which are not included in this study, and
5. To seek experts' evaluation on the responses of students' concerning the assessment of their conceptual understanding and images on the different concepts of climate change.

REFERENCES

Abano, Imelda V. (2015, December). Extreme weather: Philippines included in top of climate change risk list. *Interaksyon.com*. Retrieved April 5, 2016, from http://interaksyon.com/article/121069/philippines-included-in-top-of-climate-change-risk- list

Abejo, M. (2011). Level of awareness and acceptance on human papilloma vaccine among female call center agents: an assessment. *Master's Thesis. Unpublished*. System Technology Institute, Taguig

Abbott, C., Detheridge, T., & Detheridge C. (2006). *Symbols, literacy and social justice.* Leamington: Widgit.

Adadan, E., Irving, K. E., & Trundle, K. C. (2009). Impacts of multi-representational instruction on high school students' conceptual understandings of the particulate nature of matter. *International Journal of Science Education,* Vol. 31, pp. 1743- 1775.

Ainsworth, S. (2006). Deft: A conceptual framework for considering learning with multiple representations. *Learning and Instruction, 16*, 183-198.

Alan, Tse Ka Ho (2013). Students' perception on climate change and engagement in low-carbon behaviours: Implications for climate change education in Hongkong. *Master's Thesis. Published.* University of Hongkong

Alerby, E. (2000). A way of visualizing children's and young people's thoughts about the environment: a study of drawings. *Environmental Education Research,* Vol. 6 (3), pp. 205 - 222

Amadore, Leoncio. (2005). Crisis or opportunity: Climate change impacts and the Philippines. Greenpeace Southeast Asia.

Amato, G., & Holgate, S. (2015). Meteorological conditions, climate change, new emerging factors, and asthma and related allergic disorders. A statement of the world allergy organization. *World Allergy Organization Journal*. doi: 10.1186/s40413-015-0073-0

Anderson, B., & Wallin, A. (2000). Students' understanding of the greenhouse effect, the societal consequences of reducing $C0_2$ emissions and the problem of ozone layer depletion. *Journal of Research in Science Teaching,* Vol. 37(0), pp. 1096-1111.

Anderson, J. R. (2000). *Cognitive psychology and its implications* (5th ed.). New York: Worth Publishers.

Ametller, J., & Pinto R. (2002). Students' reading of innovative images of energy at secondary school level. *International Journal of Science Education*, Vol. 24 (3), pp. 285-312.

Aguja, S., Prudente, M., & Anito, J. (2015). Exploring climate change conceptions and attitudes: drawing implications for a framework on environmental literacy. *American Scientific Publishers*, Vol. 21, (7). doi: 10.1166/asl.2015.6294

Asan, Askin (2007). Concept mapping in science class: A case study of fifth grade students. *Educational Technology and Society*, Vol. 10 (1) pp. 186-195

Asian Development Bank (ADB) (2012). Urban sector assessment, strategy, and road map. Retrieved from http://www.adb.org/sites/default/files/publication/29896/philippines-urban- sector- road-map.pdf

Asio, V. B., Jahn, R., Perez, F. O., Navarrete, I.A., & Abit, S.M. (2009). A review of soil degradation in the Philipines. *Annals of Tropical Research* Vol. 31 (2), pp. 69-94

Avilla, R. (2009). Students' images and views of chemistry: it's implication to student achievement. *Master's Thesis. Unpublished*. Philippine Normal University, Manila

Barros, Vicente (2014). Climate change 2014: Impacts, adaptation, and vulnerability. Retrieved from http://www.hko.gov.hk/climate_change/ed_package/doc/impacts_av.pdf

Baser, Mustafa (2006). Fostering conceptual change by cognitive conflict based instruction on students' understanding of heat and temperature concepts. *Eurasia Journal of Mathematics, Science and Technology Education*, Vol 2, (2) pp. 96-114.

Bayonito, Josephine R. (2015). The perceived acceptability of the computer-assisted language learning software in teaching mandarin as foreign language. *Journal of Scientific and Research Publications*, Vol. 5, (10), p. 7

Biddulph, M., & Lambert, D., & Balderstone, D. (2015). *Learning to teach geography in the secondary school: a companion to school experience*. New York: Routledge Falmer

Birisci, S., & Metin, M. (2010). Developing an instructional material using a concept cartoon adapted to the 5E model: *A sample of teaching erosion. Asia-Pacific Forum on Science Learning and Teaching*, Vol, 11 (19) pp. 1

Boyes, E. (1995). Trainee primary teachers' ideas about the ozone layer: *Journal on Environmental Education Research*, vol. 1, pp. 133–145.

Boyes, E., & Stanisstreet, M. (1997). The Environmental Impact of Cars: children´s ideas and reasoning. *Environmental Education Research*, Vol. (3), 269-228.

Boylan, Colin (2008). Exploring elementary students' understanding of energy and climate change. *International Electronic Journal of Elementary Education*, Vol, 1, (1)

Bransford, J. D., Brown, A.L., & Cocking, R. R., editors (2000). *How people learn: Brain, mind, experience, and school, expanded edition*. National Academy Press, Washington, D.C.

By the Numbers: Ondoy, Habagat 2012, Habagat 2013. (2013, September). Retrieved, May 19, 2016 from http://www.rappler.com/newsbreak/39948-by-the-numbers-ondoy habagat-2012-2013

Campbell, L., & Campbell, B. (2009). What role does background knowledge play in learning? *Mindful learning: 101 proven strategies*. California. Corwin Press.

Capili, E.B., Ibay, A.C.S, & Villarin, J.R.T, (2005). (2005, September 19-23). Climate change impacts and adaptation on Philippines coasts. *Proceedings of the International Oceans* Conference, Washington D.C., USA

Caprio, M., W. (1994). Easing into constructivism, connecting meaningful learning with student experience. *Journal of College Science Teaching* , 23 (4), 210 -212.

Carr, Paul (2016). Climate change awareness amongst secondary level students' in a Dares Salaam University College of Education (DUCE) Affiliated School in Urban Tanzania". Published Master's Thesis, University College in Dublin, Ireland

Cinco, T., & Hilario, F., & De Guzman, R., & Ares, E. (2013, October 1-2). Climate trends and projections in the Philippines. Paper Presented at 12th National Convention on Statistics (NCS), EDSA Shangri-La Hotel, Mandaluyong City

Conniff, A., & Irvine, K.. (2016). Communicating climate change with visualization tools: a guide. *The James Hutton Institute*. Retrieved from http://www.climatexchange.org.uk/files/1414/6781/7453/Communicating_Clim ate_Change_with_Visualisation_Tools_-_FINAL_-_14_June_16.pdf

Cook, Michelle (2011). Teachers' use of visual representations in the science classroom. *Science Education International*, Vol. 22, (3), pp. 175-184

Cordero, E. C., Todd, A. M., & Abellera, D. (2008). Climate change education and the ecological footprint. *Bulletin of the American Meteorological Society*, Vol. 89 (6) pp. 865-872. doi:10.1175/2007BAMS2432.1

Cuadra, C., & Biton, N.I., & Cabacaba, K.M., & Santiago. J., & Suarez, J.K., & Lapidez, J.P., & Lagmay, A.M., & Malano, V. (2014). Development of inundation map for Bantayan Island, Cebu using delft3d-flow storm surge simulations of typhoon Haiyan. Retrieved

June 10, 2016 from http://blog.noah.dost.gov.ph/2014/10/27/development-of inundation- map- for-bantayan-island-cebu-using-delft3d-flow-storm-surge-simulations-of-typhoon-haiyan/

C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (Ed.). IPCC, (2012). Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA.

Centre for Ecology & Hydrology (CEH) (n.d). Evaporation. Retrieved from http://www.waterandclimatechange.eu/evaporation

Chang, C.Y., & Yeh, T.K., & Barufaldi, J.P. (2011). The positive and negative effects of science concept tests on student conceptual understanding. *International Journal of Science Education*. Vol. 32 (2) pp. 265-282

Chang, C.H., & Pascua, L. (2016). The hole in the sky causes global warming: A case study of secondary school students' climate change alternative conceptions. *Review of International Geographical Education,* Vol. 5 (3) pp. 316-331.

Chang, Chew-Hung. (2014). *Climate Change Education: Knowing, Doing and Being*. New York: Routledge

C. Gautier C. (2011). Using conceptual maps to assess students' climate change understanding and misconceptions". *Journal of American Geophysical Union of California*. Retrieved from http://adsabs.harvard.edu/abs/2011AGUFMED13E..02G

C. Gautier, & R. Solomon (2005). Preliminary study of students' asking quantitative scientific questions for inquiry-based climate model experiments. *Journal of Geoscience Education University of California*, Vol. 53, No.4, p.433

Cleaver, S. (2007). Classrooms are going green: How green classrooms are reconnecting kids with nature. *Instructor*, (3)117, pp. 20-24.

Coppola, Brian. (2008). Gilbert, J., & Nakhler, M., & Reiner, M. (eds.). *Visualization: theory and practice in science education*. New York: Springer.

Daniel, E.S. (2015). Students' knowledge on climate change: implications on interdisciplinary learning. Biology education and research in a changing planet: selected papers from the 25th biennial asian association for biology education conference (page 23). Retrieved from https://books.google.com.ph/books?id=07JnCgAAQBAJ&pg=PA22&lpg=PA22

&dq=the+lack
+of+knowledge+about+climate+change+endangered+vulnerable+people&source=

Dori, Y.J., & Belcher, J. (2005). How does technology-enabled active learning affect undergraduate students' understanding of electromagnetism concepts? The *Journal of the Learning Science*, Vol. 14(2) pp. 243-279

Dove, J. (1996). Student teacher understanding of the greenhouse effect, ozone layer depletion, and acid rain: *Journal on Environmental Education Research*, Vol.2, pp. 89–100.

Editorial: El Niño Advisory No. 5. Malano, Vicente (2015). *Journal on Climate Monitoring and Prediction Section (CLIMPS).* Retrieved from https://pubfiles.pagasa.dost.gov.ph/climps/weathersit/%235_ELNinoAdvisory.pdf

Eilam, B., & Poyas, Y. (2008). Learning with multiple representations: Extending multimedia learning beyond the lab. *Learning and Instruction,* Vol. 18, 368-378.

Esquivel, Vivien (2016). Climate trends and climate scenario for the Philippines. Communities for Resilience: Convergence Forum for Tagum-Libuganon River Basin Ateneo de Davao City

Evagorou, M., & Erduran, S., & Mantyla, T. (2015). The role of visual representations in scientific practices: from conceptual understanding and knowledge generation to "seeing" how science works. Journal of STEM Education. doi: 10.1186/s40594-015-0024-x

Evans, JD. (1996). *Straightforward statistics for the behavioral sciences*. California: Cole Publishing

Felipe, Cecille S. (2015, January 5). Yolanda death toll as high as 15,000. Philstar Global. Retrieved from http://www.philstar.com/headlines/2015/01/05/1409522/yolanda- death-toll-high-15000-priest-says on June 1, 2016

Friends of the Earth (FOE) (2013). Charities and campaigners. Retrieved from https://www.foe.co.uk/what_we_do/charities_23172

Furberg, Anniken (2016). Teacher support in computer-supported lab work: bridging the gap between lab experiments and students' conceptual understanding, Vol. 11 (1) pp. 89-113. doi: 10.1007/s11412-016-9229-3

De Vera, Ellalyn (2014, June). Moderately Strong El Niño. *Manila Bulletin*. Retrieved from https://www.highbeam.com/doc/1G1-370519268.html

Eylon, B. S., & Linn, M. C. (1988). Learning and instruction: An examination of 4 research perspectives in science education. *Review of Educational Research*, Vol. 58(3), 251–301.

Fitzgerald, Caren & Roberts, Karen (2016). New study examine undergraduate understanding and misconceptions of climate change. *Phys Org*. Retrieved from http://phys.org/news/2015-07-undergraduate-misconceptions-climate.html

Gilbert, J., Reiner, M. & Nakhleh, M. (2008). *Visualization: theory and practice in science education*. Dordrecht, The Netherlands: Springer.

Gilbert, John K. (2010). The role of visual representations in the learning and teaching science. *Asia- Pacific Forum on Science Learning and Teaching*, Vol. 11 (1).

Giroux-Dupigny, Lesley-Ann (2010). Exploring the challenges of climate science literacy. Lessons from students, teachers and lifelong learners. *Journal of Department of Geography*, Vol 4, pp. 1203-1217. doi: 10.1111/j.1749-8198.2010.00368.x

Global Geosphere-Biosphere Programme (IGBP) (2015). Retrieved from http://www.igbp.net/globalchange/greatacceleration.4.1b8ae20512db692f2a680001630.html

Gowda, M. V. R., Fox, J. C., & Magelky, R. D. (1997). Students' understanding of climate change: Insights for scientists and educators. *Bulletin of the American Meteorological Society Boston* , Vol, 78 (10), pp. 2232-2240.

Greenpeace Southeast Asia. (2007). Greenpeace Southeast Asia, climate and energy campaign on April 8, 2016 Retrieved from http://www.greenpeace.org/seasia/ph/Global/seasia/report/2007/4/the-philippines-a-climate-hot.pdf>

Grotzer, T. A., & Perkins, D. N. (2000). A taxonomy of causal models: The conceptual leaps between models and students' reflections on them. Paper presented at the Presented at the National Association of Research in Science Teaching (NARST) New Orleans.

Groves, F. H., & Pugh, A. F. (2002). Cognitive illusions as hindrances to learning complex environmental issues. *Journal of Science Education and Technology, 11*(4), 381- 390.

Gursel, Guler (2011). The visual representation usage levels of mathematics teachers and students in solving verbal problems. *International Journal of Humanities and Social Science*, Vol. 1 (11), pp. 145-154

Harper, K. A., Etkina, E., and Lin, Y. (2003). Encouraging and analyzing student questions in a large physics course: meaningful patterns for instructors, *Journal of Research in Science Teaching*, v. 40, pp. 776-791.

Hien, N.V., & Marin, K.M., & Kim, G.J. (2012). Education sector responses to climate change. United Nations Educational, Scientific and Cultural Organization (UNESCO) Bangkok. Retrieved May 4, 2016 from http://unesdoc.unesco.org/images/0021/002153/215305e.pdf

Holdren, J.P. (2006). Meeting the climate change challenge. Retrieved from http:www.whrc.org/resources/essay2005-2006

Howard, Kristen Elizabeth (2011). Conceptual challenges in learning ozone formation for collegiate students. *Published Master's Thesis*, Washington State University, Washington DC.

Hulme, Mike, & O'Neill, Saffron (2011). Is weather event attribution necessary for adaptation funding. *Journal on Science Communication.* Vol. 334 (6057). pp.764-765. doi: 10.1126/science.1211740

Jabines, A. & Inventor, J. (2007). The Philippines: A climate hotspot climate change impacts and the Philippines. *Journal on Greenpeace Southeast Asia, Climate and Energy Campaign*

Jeffries, H., M. Stanisstreet, and E. Boyes (2001). Knowledge about the 'greenhouse effect': have college students improved? *Res. Sci. Tech. Educ.*, 19, 205-221.

Jose, Aida M., & Cruz, Nathaniel A. (1999). Climate change impacts and responses in the Philippines: water resources. *Journal on Climate Research*. Vol. 12, pp. 77-84.

Kambouri, Maria (2015). Science learning and graphic symbols: an exploration of early years teachers' views and use of graphic symbols when teaching science. Eurasia Journal of Mathematics, Science and Technology Education, Vol. 12 (9) pp. 2399-2417. doi: 10.2973/eurasia.2016.1275a

Kavita, D. L., & Sharma, R.M. (2014).Using a constructive approach to monitor the development of conceptual understanding among science students in an urban secondary school in north trinidad. Retrieved from http://uwispace.sta.uwi.edu/dspace/bitstream/handle/2139/39236/Kavita%20Lall a.pdf?sequence=1

Korsager, Majken (2013). Globalizing the science classroom. Published Doctoral Dissertation, University of Oslo, Norway, p.10. Retrieved from https://www.duo.uio.no/bitstream/handle/10852/37294/dravhandling-korsager.pdf?sequence=1&isAllowed=y on January 5, 2016

Korsager, Majken (2015). International peer collaboration to learn about global climate changes. *International Journal of Environmental and Science Education*. doi: 10.12973/ijese.2015. 262a

Kose, Sacit. (2008). Diagnosing student misconceptions: Using drawings as a research method". *World Applied Science Journal*, Vol. 2, p. 283.

Koslow, Melinda (2013). Taken by storm. How heavy rain is worsening algal blooms in Lake Erie. *National Wildlife Federation*. Retrieved from https://www.nwf.org/~/media/PDFs/Water/Taken_By_Storm_NWF_2013.ashx

Kozma, R.B., & Russell, J. (1997). Multimedia and understanding: expert and novice responses to different representations of chemical phenomena. *Journal of Research in Science Teaching. Vol.* 34, pp. 949-968

Kozma, R. (2003). The material features of multiple representations and their cognitive and social affordances for science understanding. *Learning & Instruction* ,Vol. 13 pp. 205-226.

Kozma, R., & Russell, J. (2005). Students becoming chemists: Developing representational competence. In J. Gilbert (Ed.), *Visualization in science education,* pp. 121-146. London: Kluwer

Kreft, S., & Eckstein, D., & Junghans, L., & Kerestan, L., & Hagen, U. (2014). Global climate risk index 2015. Published by Germanwatch e.V. p. 5. Retrieved from https://germanwatch.org/en/download/10333.pdf

Kress, G., Jewitt, C., Ogborn, J., & Tsatsarelis, C. (2001). *Multimodal Teaching and Learning:The Rhetorics of the Science Classroom.* London: Continuum.

Lagmay, A.M.F., & Mendoza, J., & Punay K., Tingin, N.E., & Delmendo, P.A., & Cipriano, F., & Serrano, J., & Sabio, G., & Moise, M.A. (2015). Street floods in Metro Manila and possible solutions. *National Institute of Geological Sciences, University of the Philippines*. Retrieved from http://blog.noah.dost.gov.ph/2015/11/09/street-floods-in-metro-manila-and- possible-solutions/

Lalla, Kavita Devi (2014). Using a constructive approach to monitor the development of conceptual understanding among science students in an urban secondary school in North Trinidad. *Published Master's Thesis*, University of the West Indies,

Landis, Jr. & Koch, G. (1977). The measurement of observer agreement for categorical data. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/843571

Lan, Ong Saw (2007). Assessing conceptual understanding of science. Retrieved from http://education.usm.my/images/docs/DigesPendidik/DP2007-2/4.pdf

Lansangan, Ryan V. (2012). Representational competence profile of secondary chemistry students in understanding selected chemical principles, Philippine Normal University, Manila

Lapus, Jesli (2008). Disaster risk reduction resource Manual, Published by the Department of Education (DepEd) Philippines. Retrieved from http://www.deped.gov.ph/sites/default/files/Disaster%20Risk%20Reduction%20Resource%20Manual.pdf

Lawson, A.E. (2002). Robert Karplus, ed. R.G. Fuller (Eds.). *The learning cycle. In A love of discovery: Science education—the second career* (pp.51-62). New York: Kluwer Academic Press/Plenum

Lawson, M.J. (1994). Concept mapping. In T. Husen & T.N. Postlethwaite (Eds.). *The International Encyclopedia of Education, (*pp. 1026-1031). Oxford: Elsevier

Lee, B., & Ma, Li., & Lambert J., & Baptiste, M. (2007). Conceptions of the greenhouse effect and global warming among elementary students from diverse languages and cultures. *Journal of Geoscience Education,* Vol. 55 pp. 117-125

Lee, 0., Lester, B., Ma, L., Lambert, J., & Jean-Baptiste, M. (2007). Conceptions of the greenhouse effect and global warming among elementary students from diverse languages and cultures. *Journal of Geoscience Education,* Vol. 55 (2), pp. 117-125.

Legarda, Loren (2013, June). Extreme Weather: Heavy Rains, Floods are "New Norm". *Philippine Daily Inquirer*. Retrieved from http://newsinfo.inquirer.net/431237/extreme-extreme-weather-heavy-rains-floods-are-new-norm

Lemke, Jay (2004). Teaching all the languages of science: words, symbols, images, and actions. Retrieved from http://academic.brooklyn.cuny.edu/education/jlemke/papers/bacerlon.htm

Liu, L., & Hmelo G Silver, C. E. (2009). Promoting complex systems learning through the use of conceptual representations in hypermedia. *Journal of Research in Science Teaching*, Vol. 46 (9), 1023-1040

Luera, G. R., Otto, C. A. & Zitzewitz, P. W. (2005). A conceptual change approach to teaching energy & thermodynamics to pre-service elementary teachers. *Journal of Teacher Educ*ation Online.Vol. 2 (4) pp. 3-8

Lombardi, Douglas (2012). Students' conceptions about climate change: using critical evaluation to influence plausibility reappraisals and knowledge reconstruction. *Published Doctoral Dissertation in Educational Psychology*, University of Nevada, Las Vegas p.2. Retrieved May 5, 2015 from http://digitalscholarship.unlv.edu/cgi/viewcontent.cgi?article=2592&context=thesesdissertations

Longshore, D. (2008). *Encyclopedia of hurricanes, typhoons and cyclones, New Edition*. Facts on File, Inc., New York.

Lucero, Anthony (2016). How vulnerable is Mindanao to El Niño. Retrieved from http://www.rappler.com/move-ph/issues/disasters/127991-how-vulnerable-mindanao-el-nino

Macas, Trisha, Malano, Vicente (2015). Bracing for the effects of a continuing strong El Niño in 2016. *GMA News Online*. Retrieved from http://www.gmanetwork.com/news/story/549416/scitech/science/bracing-for-the-effects-of-a-continuing-strong-el-nino-in-2016

Maplecroft (2012). Climate change vulnerability index. Retrieved from http://www.maplecroft.com/about/news/ccvi.html.

Mason, Lucia and Santi, Marina (1998). Discussing the greenhouse effect: children's collaborative discourse reasoning and conceptual change. *Environmental Education Research*, Vol. 4, No. 1, pp. 67-85.

Mayer, R. E. (1997). Multimedia learning: Are we asking the right questions? *Educational Psychologist, Vol. 32* (1), pp. 1-19.

Mayer, R. E. (2003). The promise of multimedia learning: using the same instructional design methods across different media. *Learning and Instruction.* Vol. 13, pp. 125-139.

McCabe, D., & Castle, A. (2007). *Seeing is believing: The effect of brain images on judgments of scientific reasoning*. Department of Psychology, University of California.

McConnell, M., & Liverman, D., & Raven, P., (2010). Education and communication. Informing an effective response to climate change. (pp. 256-257). doi: 10.17226/12784

McNeill, K.L., & Vaughn, M.H. (2010). Urban high school students' critical science agency: Conceptual understandings and environmental actions around climate change. *Research in Science Education*, Vol. 42, (2), pp. 373-399

Medina, Conni (2007). Macceca, Stephanie (Ed.). Reading strategies for science. California: Shell Education

Moe, Jeanne Marie. "Conceptual understanding of science through archaeological inquiry." Published Master's Thesis, Montana State University, Montana, 2011

Mohan, L., Chen, J., & Anderson, C. W. (2009). Developing a multi-year learning progression for carbon cycling in socio-ecological systems. *Journal of Research in Science Teaching*, Vol. 46 (6), pp. 675-698.

Mohan, L., & Ingber, J. (n.d). Changing climate. *Retrieved from National Geographic*

Moloney, G., & Leviston, Z., & Lynam, T. (2014). Using social representations theory to make sense of climate change: what scientists and nonscientists in australia think. *Journal on Ecology and Society* Vol. 19, No. 3 p.1

Moran, R.K., & Keeley, P. (2015). Teaching science for conceptual understanding: An overview. In Rubin, W., & Cooke, A., & O'Brien, A., & Yudkin, D., *Teaching for conceptual understanding in science* (p. 6). Retrieved from http://static.nsta.org/files/PB359Xweb.pdf

Moser, S. C., & Dilling, L. (2004). Making climate hot. Environment: Science and Policy for Sustainable Development, Vol. 46 (10), pp. 32-46.

Nam, Y., & Ito, E. (2011). A climate change course for undergraduate students. *Journal of Geoscience Education*, Vol. 59, No. 4, pp. 229-241. doi: 10.5408/1.3651405

NASA. (2012). Global Climate Change. Retrieved from http://climate.nasa.gov/

National Aeronautics and Space Administration (NASA) (2016). Global climate change. Retrieved from http://climate.nasa.gov/effects/

National Geographic. (n.d.). Deforestation. Retrieved April 15, 2016, from http://environment.nationalgeographic.com/environment/globalwarming/deforestationoverview/

National Oceanic and Atmospheric Administration (NOAA) (2016). What are El Niño and La Niña. Retrieved from http://oceanservice.noaa.gov/facts/ninonina.html

National Wildlife Federation (NWF) (2013). Global warming and floods. Retrieved https://www.nwf.org/Wildlife/Threats-to-Wildlife/Global-Warming/Global-Warming-is-Causing-Extreme-Weather/Floods.aspx

National Wildlife Federation (NWF) (2016). Global warming and extreme weather. Retrieved from https://www.nwf.org/Wildlife/Threats-to-Wildlife/Global-Warming/Global-Warming-is-Causing-Extreme-Weather.aspx

NC State University (n.d.). Global patterns-El Niño-southern oscillation (ENSO). Retrieved from http://climate.ncsu.edu/climate/patterns/ENSO.html

Nicholson-Cole, S. A. (2005). Representing climate change futures: a critique on the use of images for visual communication. *Computers, Environment and Urban Systems*, 29 (3), pp. 255-273. doi.org/10.1016/j.compenvurbsys.2004.05.002

North Carolina State University (2013). Tropical cyclones. Retrieved from http://climate.ncsu.edu/edu/k12/.tropicalcyclones

Ochieng, M. & (2013). The level of climate change awareness and perception among primary school teachers in Kisumu municipality, Kenya. *International Journal of Humanities and Social Science*, Vol. 3 (21) pp. 174-179

Olan, Sarah Jane (2014). Looking back: the records of Ondoy. Retrieved from http://www.rappler.com/move-ph/issues/disasters/70240-ondoy-records

Olson, Joanne K. (2008). The science representation continuum. *Journal on National Research Council* (NRC). National Science Education Standards. p. 52

Oluk, S., & Ozalp, I. (2007). The teaching of global environmental problems according to the constructivist approach: As a focal point of the problem and the availability of concept cartoons. *Educational Sciences: Theory & Practice*, (7) 2, pp. 881-896.

Oversby, J. (2002). Assessing conceptual understanding in Amos, S & Boohan, R. (Ed). *Aspects of Teaching Secondary Science: Perspectives on Practice, The Open University.* London & N.Y.

Ozel, Murat (2012). Children's images of scientist: Does grade level make a difference? *Educational Sciences: Theory & Practice*. Retrieved from www.edam.com.tr/estp

PAGASA, MMDA list flood-prone areas in NCR, other regions. *GMA Network*. Retrieved from http://www.gmanetwork.com/news/story/547818/news/nation/pagasa-mmda-list-flood-prone-areas-in-ncr-other-regions

Park, E.J. & Light, G. (2009). Identifying atomic structure as a threshold concept: student mental models and troublesomeness. *International Journal of Science Education*, Vol. 31, No. 2. pp. 233–258.

Patrick, M. D., Carter, G., & Wiebe, E. N. (2005). Visual representations of DNA replication: Middle grades students‘ perceptions and interpretations. *Journal of Science Education and Technology*, Vol. 14, pp. 353-365

Pauwels, L. (2006). *A theoretical framework for assessing visual representational practices in knowledge building and science communications*. In Pauwels (Ed.), Lebanon, NH: Darthmouth College Press.

Pearce, Fred (2016). El Niño and climate change: wild weather may get wilder. Retrieved from http://e360.yale.edu/feature/el_nino_and_climate_change_wild_weather_may_get_wilder/2960/

Picker, S. & J. Berry. (2000). Investigating pupils' images of mathematicians. *Educational Studies in Mathematics*, Vol. 43, pp. 65-94

Prain, V. (2006). Learning from writing in secondary science: Some theoretical and practical implications. *International Journal of Science Education,* Vol. 28, pp. 179-201.

Nixon, Ryan S. (2012). Explicitly teaching multiple modes of representation in science discourse: the impact on middle school science student learning. *Published Master's Thesis*, Brigham Young University in Utah, USA

Novak, J.D. (1977). *A theory of education*. Ithaca, NY: Cornell University Press.

O'Neill, Saffron J. (2013). On the use of imagery for climate change engagement. *Journal on Global Environmental Science*, Vol. 23 (2), pp. 413-421

Olmanson, Aaron Kent (2011). The effects of students drawing in their science notebooks on their understanding of science in seventh grade science. *Published Master's Thesis*, Montana State University, Montana USA. Retrieved from http://scholarworks.montana.edu/xmlui/bitstream/handle/1/1986/OlmansonA0811.pdf?sequence=1

Owens, K.D. & Clements, M.A. (1998). Representations In Spatial Problem Solving In The Classroom. *The Journal of Mathematical Behaviour*, Vol, 17 pp. 197-218.

Papadimitriou, V. (2004). Prospective primary teachers' understanding of climate change, greenhouse effects and ozone layer depletion. *Journal of Science Education and Technology, 13*(2), 299-307.

Panprueksa, K., & Phonphok, N., & Boonprakob, M., & Dahsah, C. (2012). Thai students' conceptual understanding on force and motion. *Behavioral Science Research Institute Journal*, Vol. 30. pp. 275-279.

Piaget, J. (1968). *Judgment and reasoning in the child* (M. Warden, Trans.). Totowa, NJ: Littlefield & Adams.

Pielke, Roger Sr (2012). Pielke Research Group: News and Commentary. (2013, July). Retrieved from https://pielkeclimatesci.wordpress.com/2012/01/19/what-does-climate-change-mean-does-a-lack-of-preciseness-in-its-definition-discourage-effective-discussion-of-the- risks-from-climate- on-key-societal-and-environmental-resources/

National Geographic (2016). Retrieved from http://ocean.nationalgeographic.com/ocean/explore/pristine-seas/critical-issues-sea-temperature-rise/

Perkins, D.N., Crismond, D., Simmons, R., & Unger, C. (1995). Inside understanding. In J.L.S.D.N. Perkins, M.M. West, & M.S. Wiske (Eds.), *Software goes to school: Teaching for understanding with new technologies* (pp. 70 - 91). New York: Oxford University Press.

Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) (2014). Climatology and Agrometeorology. Retrieved from http://www.pagasa.dost.gov.ph/index.php/sl-weather/rainfall-warning-2/27-climatology-and-agrometeorology

Philippine Institute for Development Studies (2005). Retrieved from http://www.pids.gov.ph

Philippine Red Cross (PRC). (2016, April). Philippines: Drought and dry spells-information bulletin no. 1. Retrieved from http://reliefweb.int/report/philippines/philippines-drought-and- dry-spells-information-bulletin-no-1

Pitpitunge, A., Caranto, B. (2015). Students' perceptions about climate change. *Asian Journal of Biology Education* Vol. 7, p. 2. Retrieved from http://aabe.sakura.ne.jp/Journal/Papers/Vol7/02%20Pitpitunge.pdf

Rebich, S., & Gautier, C. (2005). Concept mapping to reveal prior knowledge and conceptual change in a mock summit course on global climate change. *Journal of Geoscience Education*, Vol. 53 (4), pp. 355.

Reinfried, S., & Aeschbacher, U., & Benno, R. (2012). Improving students' conceptual understanding of the greenhouse effect using theory-based learning materials that promote deep learning. *International Research in Geographical and Environmental Education*. Vol, 21.doi:10.1080/10382046.2012.672685

Rittle-Johnson, B., Siegler, R. S., & Alibali, M. W. (2001). Developing conceptual understanding and procedural skill in mathematics: An iterative process. *Journal of Educational Psychology*, *93*, 346-362. Retrieved from https://www.uni trier.de/fileadmin/fb1/prof/PSY/PAE/Team/Schneider/RittleJohnsonSchneiderIn Press.pdf

Robbegalle, T. & Ralle, B. (2014). Promoting a better understanding of global change phenomena - a design based research project. Retrieved from http://www.esera.org/media/esera2013/Thomas_Ro%C3%9Fbegalle_10Feb201 4.pdf

Rogers, D.R., & Tsirkunov, V.V. (2013). Weather and climate resilience. Effective preparedness through national meteorological and hydrological services. Retrieved,

May 2, 2016 from http://openknowledge.worldbank.org/bitstream/handle/10986/15932/81113.pdf?sequence=1

Rye, J.A., & Strong, D.D., & Rubba, P.A. (2001). Global warming and ozone depletion. *Journal on Science Education*. Retrieved http://www.socialstudies.org/system/files/publications/se/6502/650202.html

Saleh, S. (2011). The level of B.Sc.Ed students' conceptual understanding of newtonian physics. *International Journal of Academic Research in Business and Social Sciences, 1*(3), 249-256.

Salinger, Timothy (2016). An assessment of climate change imagery in the UK's media. Retrieved from http://www.e-ir.info/2016/03/05/an-assessment-of-climate-change-imagery-in-the-uks-media/

Sarmiento, B.G, and Guevara, C.A. (2016). Students' conceptual understanding and attitude on climate change resilience and mitigation practices. *International Journal of Educational Science and Research (IJESR)*, Vol, 6(2)

Schönborn, K.J., and Anderson, T.R., 2009. A Model of Factors Determining Students' Ability to Interpret External Representations in Biochemistry. *International Journal of Science Education*. 31, No. 2, pp. 193–232

Schwartz, D., & Heiser, J. (2006). Spatial Representation and Imagery in Learning. Retrieved from http://aaalab.stanford.edu/papers/Spatial_Representation_and_Learning. http://aaalab.stanford.edu/papers/Spatial_Representation_and_Learning.pdf on September 5, 2015

Servando, Nathaniel (February, 2011). Climate change in the Philippines. D*epartment of Science and Technology - Philippine Atmospheric, Geophysical & Astronomical Services Administration (DOST-PAGASA)*.Retrieved from https://pubfiles.pagasa.dost.gov.ph/climps/climateforum/ClimatechangeinthePhilippines.pdf on September 19, 2015

Shaw, Sophia (2014). The guardian news and media limited. U.S. Department of Education. Retrieved from http://www.theguardian.com/commentisfree/2014/sep/19/its-time-to-teach-climate-change-in-school-heres-how>

Shepardson, D., & Niyogi, D., & Choi, S., & Charusombat, U. (2012). Seventh grade students' conceptions of global warming and climate change. *Journal on Environmental Educational Research*, Purdue University, West Lafayette, Indiana, Vol. 18, No. 5, p. 10

Shepardson, D., & Niyogi, D., & Anita, R., & Hirsh, Andrew (2012). Conceptualizing climate change in the context of a climate change: Implications for climate and environmental education. Journal Education Research,Vol. 18 (3) pp. 323-352

Sieber, E., & Hatcher, S. (2012). *Teaching with objects and photographs*. Bloomington, Indiana. Mathers Museum of World Cultures

Sinatra, G. M. & Chinn, C. (2011). Thinking and reasoning in science: promoting epistemic conceptual change. In K. Harris, C. B. McCormick, G. M. Sinatra, & J. Sweller (Eds.). *Critical Theories and Models of Learning and Development Relevant to Learning and Teaching*, Volume 1, pp. 257-282)

Singer, S. R., & Nielsen, N.R., & Schweingruber, H.A. (Eds.) (2012). *Discipline-based education research: Understanding and improving learning in undergraduate science and engineering*. National Research Council, Washington DC: The National Academic Press.

Slinger, Jonathan (2011). Threshold concepts in secondary geography education. The Geographical Association Conference, University of Surrey

Smith, N. and Joffe, H. (2009). Climate change in the British press: the role of the visual. *Journal of Risk Research*, Vol. 12 (5) pp. 647-663.

Solaz-Portolės, J.J., and Lopez, V.S. (2007). Representations in problem solving in science: Directions for practice. *Asia-Pacific Forum on Science Learning and Teaching*, 8, No. 2. Article 4

Staver, J. R. (1998). Constructivism: Sound theory of explicating the practice of science and science teaching. *Journal of Research in Science Teaching*, 35, 501-520.

Stylianidou, F., & Ormerod, F. (2002). Analysis of science textbook pictures about energy and pupils‘ readings of them. *International Journal of Science Education*, Vol. 24 (3), 257- 283

Summers, M., Kruger, C., Childs, A., and Mant, J. (2000). Primary school teachers' understanding of environmental issues: An interview study: *Journal on Environmental Education Research*, Vol. 6, pp. 293–312.

Summers, M., Kruger, C., and Childs, A. (2001). Understanding the science of environmental issues: Development of a subject knowledge guide for primary teacher education: *International Journal of Science Education*, Vol. 23, pp. 33–53.

Sunyono, L. Yuanita, Ibrahim (2015). Supporting students in learning with multiple representation to improve student mental models on atomic structure concepts. *Science Education International*. Vol. 26 (2) pp. 104-125

Sutopo, L., & Waldrip, B., & Rusdiana, D. (2011). The Need of representation approach to provide prospective physics. *International Seminar of Science Education.* Published Master's Thesis, State University of Malang, Indonesia p.1

Teaching Teachers: Professional Development to Improve Student Achievement. (n.d.). Teaching Tolerance. Retrieved from http://www.tolerance.org/article/teaching-teachers-professional-development-improve-student-a

Tejada, S., Tuddao, V., Juanillo, E., Brampio, E. (n.d.). Drought conditions and management strategies in the Philippines

Tejano, Ivy. C. (2016, April), Cloudy skies in Davao this week - PAGASA. Sunstar Davao. Retrieved from http://www.sunstar.com.ph/davao/local-news/2016/04/24/cloudy- skies-davao-week-pagasa-469674

The International Disaster Database (EM-DAT) Home Page. (2009). Centre for Research on the Epidemiology of Disasters - CRED. March 4, 2016. Retrieved from http://www.emdat.be/classification

The World Bank Group. (2016). Average precipitation in depth (mm per year) in Philippines. Retrieved June 5, 2016 from http://data.worldbank.org/indicator/AG.LND.PRCP.MM

Thompson, Andrea (2015). Global warming key driver of 2015's record heat. Retrieved from http://www.climatecentral.org/news/global-warming-key-driver-record-heat-19734

Torrecilla, Francisco J. (2013). Visual learning in science education a powerful tool. Journal in New Perspective in Science Education. Retrieved from http://conference.pixel-online.net/npse2013/common/download/Paper_pdf/106-ESM02-FP-Torrecilla-NPSE2013.pdf

Trend, R.D. (2001). Deep time framework: A preliminary study of U.K. primary teachers' conceptions of geological time and perceptions of geosciences: *Journal of Research in Science Teaching*, Vol. 38, pp. 191–221.

Tsantakis, Tina (2009). Student awareness on global warming. Retrieved June 4, 2015, from https://actionresearchprojects.wikispaces.com/.../Tina's+Final+Powerpoint+Final Version

Tschakert, P., & Sagoe, R. (2009). Mental models: understanding the causes and consequences of climate change. Retrieved from http://pubs.iied.org/pdfs/G02823.pdf

Turnbull, Malcolm (2015). What are greenhouse gases? *Conserve Energy Future*. Retrieved from http://www.conserve-energy-future.com/greenhouse-gases.php

Tytler, H., R., & Haslam, F. (2010). Teaching and learning about force with a representational focus: pedagogy and teacher change. *Research in Science Education, Vol.* 40 (1) pp. 5-28.

Tytler, R., & Prain, V., & Hubber, H., & Waldrip, Bruce (2014). *Constructing Representations to Learn in Science*. Netherlands: Sense Publishers

United Nations Educational Cultural and Scientific Organization (UNESCO). (2011). *Climate change starter's guidebook: An issues guide for education planners and practitioners.* Retrieved Apr 26, 2013, from http://unesdoc.unesco.org/images/0021/002111/211136e.pdf

United Nations Educational, Scientific and Cultural Organization (UNESCO) (2007). Climate change education and awareness. Retrieved from http://en.unesco.org/themes/addressing-climate-change/climate-change-education-and-awareness

United Nations (UN) (2015). Centre for research on epidemiology of disasters - CRED and united nations office for disaster risk reduction ((UNISDR). Retrieve from http://www.emdat.be/publications

United States Environmental Protection Agency (EPA) Home Page. February 2, 2016. United States Environmental Protection Agency (EPA). May 3, 2016. < https://www3.epa.gov/climatechange/science/indicators/ghg/>

Van der Meij, J., & de Jong, T. (2006). Supporting students' learning with multiple representations in a dynamic simulation-based learning environment. *Learning and Instruction,* Vol. 16, 199-212.

Von Glaserfeld, E.(1989). *Constructivism in education*. In T. Husen & T.N. Postlethwaite (Eds.), The international encyclopedia of education, supplement, Vol. 1 (pp. 162-163). Oxford/New York: Pergamon Press.

World Wildlife Org. (2016). Effects of climate change. Retrieved from http://www.worldwildlife.org/threats/effects-of-climate-change

Wu, H.K., & Krajcik, J.S., & Soloway, E. (2001). Promoting understanding of chemical representations: students' use of a visualization tool in the classroom. *Journal of Research in Science Teaching,* Vol. 38, No. 7, p.823.

Van der Meij, J., & de Jong, T. (2006). Supporting students' learning with multiple representations in a dynamic simulation-based learning environment. *Learning and Instruction* ,Vol. 16, pp. 199- 212.

Vavra, K., & Watrich, V., & Loerke, K., & Phillips, L., & Norris, S., & Macnab, S. (2011). Visualization in science education. *Ain Shams Engineering Journal*, Vol. 41, (1) pp. 26-30.

Viennot, Laurence. (2009). Learning and conceptual understanding: beyond simplistic ideas, what have we learned. *International Journal on Science Education*. LDSP, University Denis Diderot. Retrieved from https://web.phys.ksi.edu/icpe/publications/teach2/viennot.pdf

Viereck, G.S. (1929). What life means to Einstein: An interview by George Sylvester Viereck. The Saturday Evening Post. Retrieved from http://web.mit.edu/edtech/pdf/teal1.pdf

Vosniadou, S. & Brewer, W. (1992). Mental models of the earth. *Cognitive Psychology*, Vol. 24 (4) pp. 535-585

Wang, J. R. (2004). Development and validation of a two-tier instrument to examine understanding of internal transport in plants and the human circulatory system. *International Journal of Science and Mathematics Education, 2*(2), 131-157.

Wong, M., & Evans, D., (2011). Students' conceptual understanding of equivalent fractions". E- Journal on Mathematics, 2, 825-826. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.607.7837&rep=rep1&type=pdf

World Health Organization (WHO) (2016). El Niño and health. Global overview - January 2016. Retrieved from http://www.who.int/hac/crises/el nino/who_el_nino_and health_global_report_21jan2016.pdf

Yilmaz, H., & Turkmen, H., & Pedersen, J. (2007). Evaluation of pre-service teachers' images of science teaching in Turkey. Department Teaching, Learning and Teacher Education p. 80. Retrieved from http://digitalcommons.unl.edu/teachlearnfacpub/80

Yılmaz, H., & Huyuguzel Cavas, P. (2006). The effect of the 4-e learning cycle method on students' understanding of electricity. *Journal of Turkish Science Education*, 3(1), 2-5

Yuruk, Nejla (2007). The effect of supplementing instruction with conceptual change texts on students' conceptions of electrochemical cells. *Journal of Science Education and Technology*, Vol. 16, (6) pp. 515-523

Zirbel, Esther L. "Teaching to promote deep understanding and instigate conceptual change". *Published Doctoral Dissertation*, Tufts University, Medford Massachusetts 2005, p.3. Retrieved from http://cosmos.phy.tufts.edu/~zirbel/ScienceEd/Teaching-for-Conceptual-Change.pdf on July 4, 2015

6 ways climate change will affect PH cities: (2015, October 22). Retrieved from http://www.rappler.com/nation/48599-six-ways-climate-change-affects-ph-cities on June 4, 2016

APPENDICES

APPENDIX A

Task Instrument

Conceptual Understanding and Images

Task Instrument on Climate Change

Part I. Respondent's Profile
Please fill in the needed information on the spaces provided.

Name (optional): _____ **Year & Section:** _____

Name of School: _____ **Gender:** _____

Type of School: _____ **Age:** _____

Part II. Task Instrument on Climate Change

GENERAL INSTRUCTIONS:

The primary purpose of the study is to probe student's conceptual understanding and images or conceptual representation about the different concepts on climate change. The following climate change concepts have been discussed in your earth science class last academic year. Rest assured that the results and data gathered from this study will not affect your academic performance and will be treated with high level of confidentiality.

1. *There will be six (6) tasks in this instrument that will probe your concepts and images on the different concepts on climate change.*

2. *Each task provides spaces for your responses and illustrations, thus making each task divided into two parts:*

    a. Part 1 – you are asked to give the probable cause and effect of each concept on climate change. Excerpts in this task are based on news articles and literature from PAGASA, DENR and Climate Change Commission.
    b. Part 2 – you are asked to make an illustration or image for each concept on climate change.

3. *Your response can be written in any language of your choice.*

4. *You are given 45 minutes to accomplish the task. Kindly use the spaces provided on each task.*

Tasks 1.1	*Temperature*

Climate change pertains to the changes in our climate system over a period of time. This includes natural and man-made or anthropogenic activities. Human-induced warming is superimposed on a naturally varying climate. It has been predicted by PAGASA that Philippines would get warmer and more intense in the summer months in 2020 and 2050 (Servando, 2011).

On the space provided below, write the possible causes of the increase of temperature and their effects to the rate of precipitation.

Cause/s	**Effect/s**

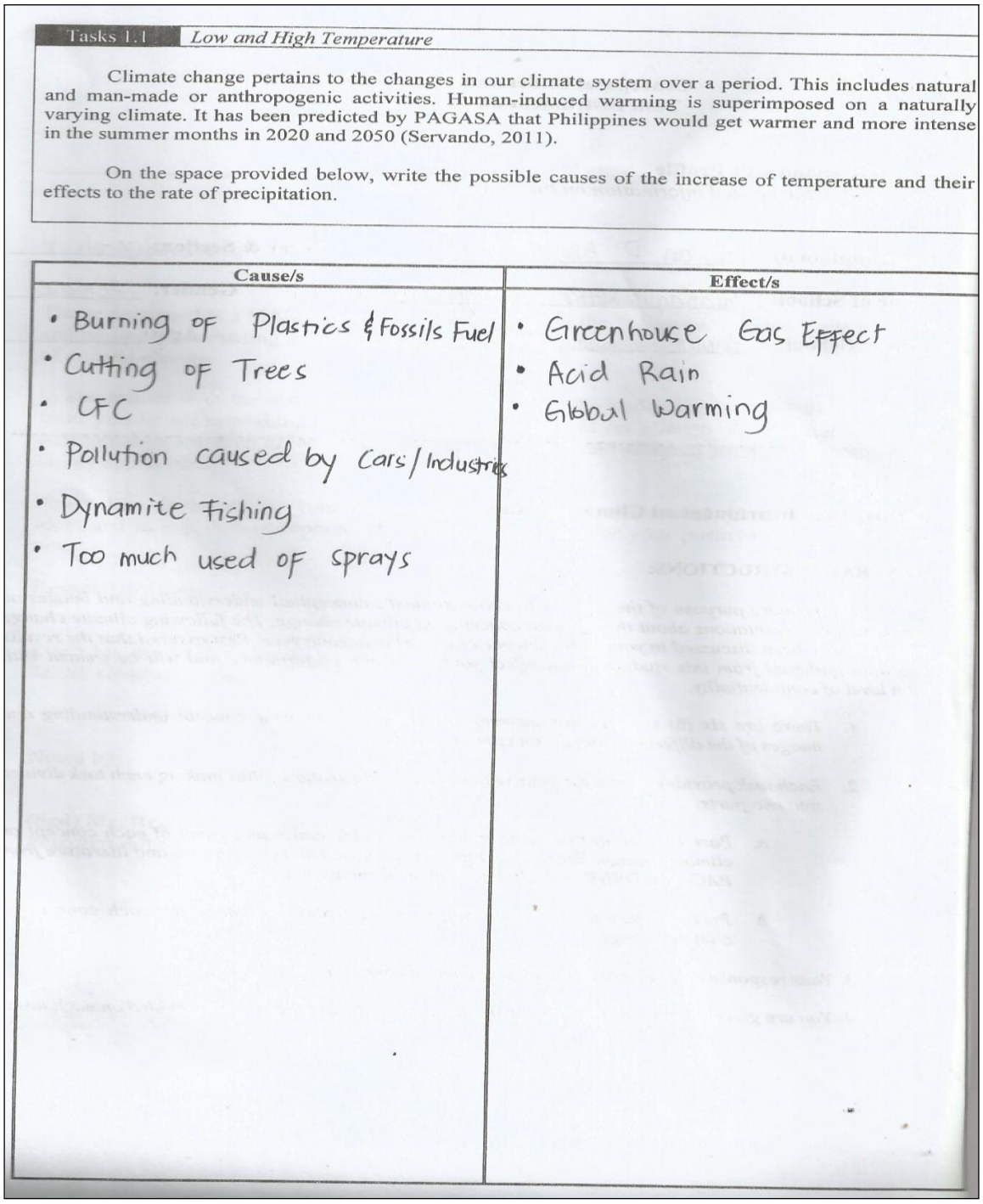
Tasks 1.2	*Temperature*

The main impact of climate change is an increase of global temperature. In the space provided below, make an illustration or image demonstrating the concept of the formation of rain in the presence of temperature.

APPENDIX B

Sample of Students' Response on the EITI

Appendix B1



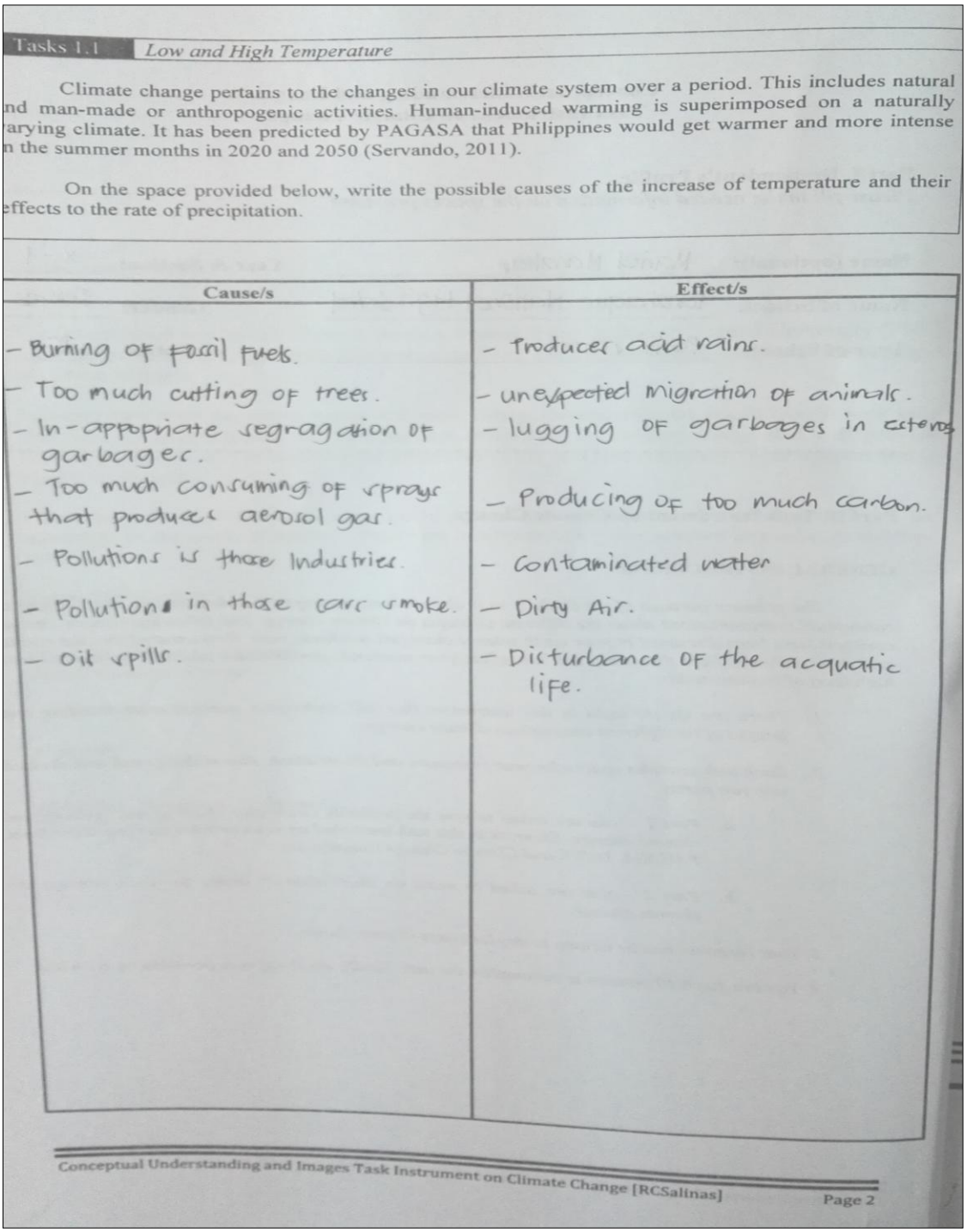
Tasks 1.1 *Low and High Temperature*

Climate change pertains to the changes in our climate system over a period. This includes natural and man-made or anthropogenic activities. Human-induced warming is superimposed on a naturally varying climate. It has been predicted by PAGASA that Philippines would get warmer and more intense in the summer months in 2020 and 2050 (Servando, 2011).

On the space provided below, write the possible causes of the increase of temperature and their effects to the rate of precipitation.

Cause/s	Effect/s
• Burning of Plastics & Fossils Fuel • Cutting of Trees • CFC • Pollution caused by Cars/Industries • Dynamite Fishing • Too much used of sprays	• Greenhouse Gas Effect • Acid Rain • Global Warming

Appendix B2



Tasks 1.1 *Low and High Temperature*

Climate change pertains to the changes in our climate system over a period. This includes natural nd man-made or anthropogenic activities. Human-induced warming is superimposed on a naturally arying climate. It has been predicted by PAGASA that Philippines would get warmer and more intense n the summer months in 2020 and 2050 (Servando, 2011).

On the space provided below, write the possible causes of the increase of temperature and their effects to the rate of precipitation.

Cause/s	Effect/s
- Burning of fossil fuels. - Too much cutting of trees. - In-appopriate segragation of garbages. - Too much consuming of sprays that produces aerosol gas. - Pollutions is those Industries. - Pollutions in those cars smoke. - Oil spills.	- Producer acid rains. - unexpected migration of animals. - lugging of garbages in esteros - Producing of too much carbon. - Contaminated water - Dirty Air. - Dicturbance of the acquatic life.

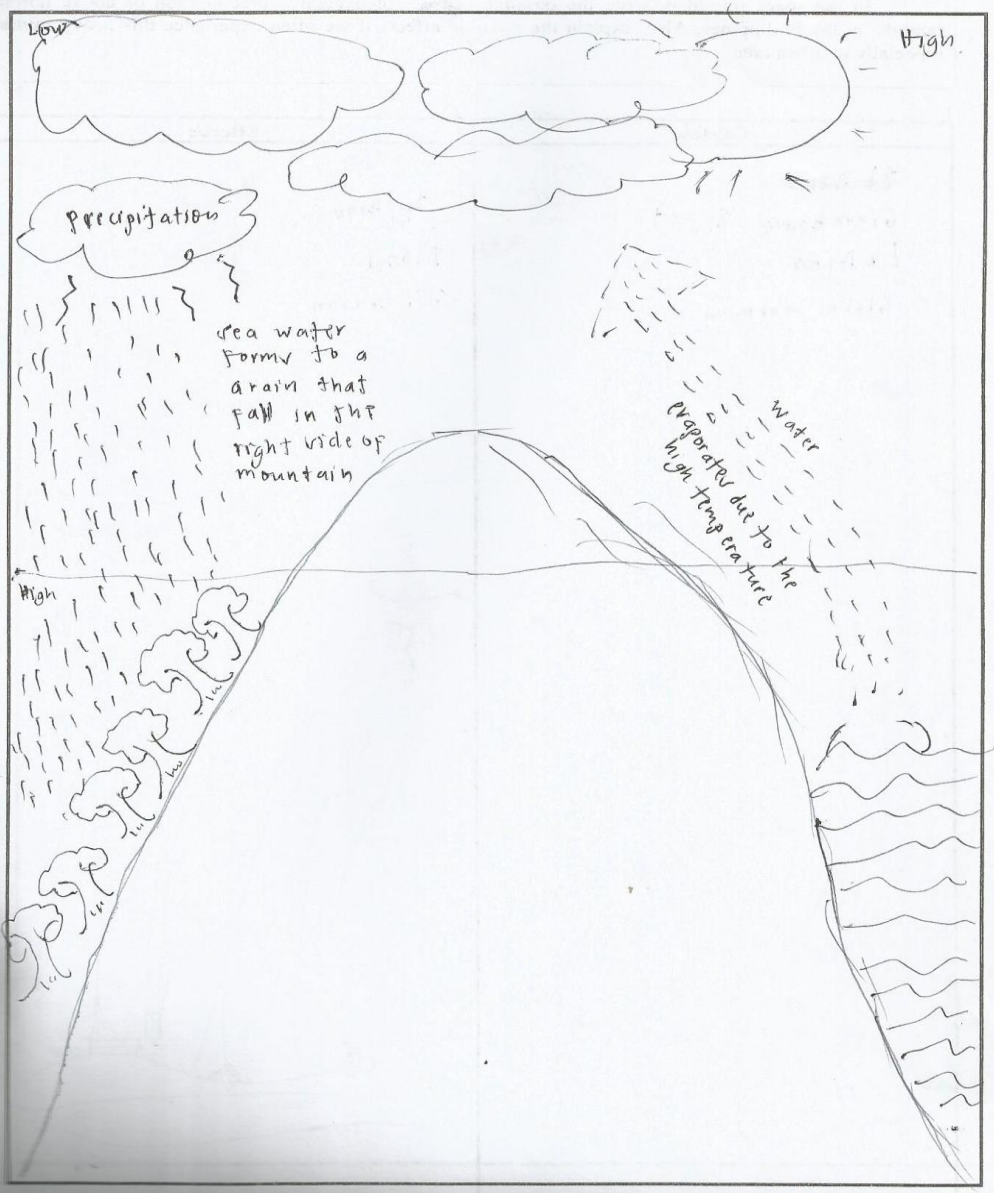
Conceptual Understanding and Images Task Instrument on Climate Change [RCSalinas] Page 2

Appendix B3

A : 19

Tasks 1.2 *Low and High Temperature*

The main impact of climate change is an increase of global temperature. In the space provided below, make an illustration or image demonstrating the concept of the formation of rain in the presence of low and high temperature.

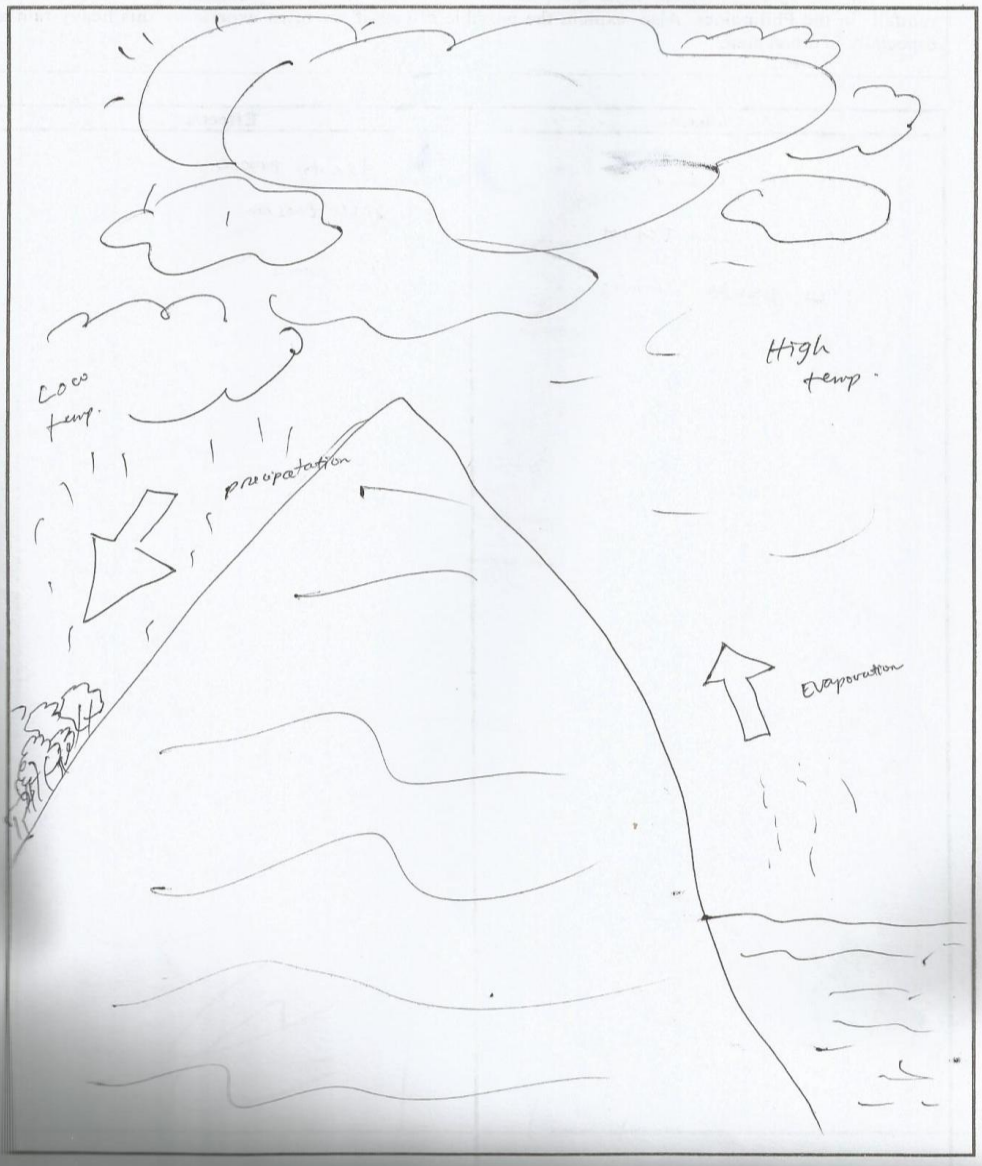


Appendix B4

A: 20

Tasks 1.2 *Low and High Temperature*

The main impact of climate change is an increase of global temperature. In the space provided below, make an illustration or image demonstrating the concept of the formation of rain in the presence of low and high temperature.



APPENDIX C

Summary of Data

Appendix C1

	TASK NO. 1			TASK NO. 2			TASK NO. 3			TASK NO. 4			TASK NO. 5			TASK NO. 6		
	TEMPERATURE			RAINFALL			CYCLONE			DROUGHT			EXTREME METEOROLOGICAL CONDITION			GREENHOUSE GASES		
STUDENT NO.	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE
Student 1	1	1	1	3	2	1	3	3	2	3	3	2	3	3	2	3	3	3
Student 2	4	2	1	2	3	1	3	3	1	3	4	1	3	3	2	4	4	2
Student 3	4	2	1	2	3	1	2	2	1	3	3	1	4	2	2	4	3	2
Student 4	4	4	2	3	3	3	3	3	2	3	4	1	4	2	2	4	3	1
Student 5	4	3	2	2	3	1	3	3	2	3	4	1	4	4	2	3	3	2
Student 6	4	4	2	3	3	1	3	3	1	3	3	3	4	3	2	4	3	3
Student 7	4	2	2	2	3	1	3	3	1	3	4	1	4	3	2	4	4	3
Student 8	4	2	2	2	3	1	2	1	1	3	4	1	1	1	2	4	3	1
Student 9	4	4	2	3	3	1	3	2	1	3	4	1	4	3	2	1	3	3
Student 10	4	2	1	3	3	1	3	3	2	3	3	1	4	3	2	4	4	3
Student 11	4	2	2	3	2	1	3	3	2	3	4	1	4	3	1	3	3	2
Student 12	4	3	2	3	3	2	3	3	2	3	3	1	3	2	1	3	3	2
Student 13	4	2	2	3	3	1	3	3	1	3	3	1	3	3	2	4	4	3
Student 14	4	2	2	1	2	3	3	3	2	1	4	1	1	1	1	1	1	1
Student 15	4	4	2	3	3	2	3	3	1	3	4	1	4	3	2	4	4	3
Student 16	4	4	2	3	3	1	3	3	2	3	4	1	4	3	2	4	3	2
Student 17	4	4	2	3	3	1	3	3	1	3	4	1	4	3	1	4	4	1
Student 18	4	4	2	3	3	1	3	3	1	3	4	1	4	3	2	4	4	3
Student 19	4	2	2	3	3	2	3	3	2	3	4	1	4	3	2	4	4	3
Student 20	4	2	2	3	3	1	3	3	2	3	4	1	4	3	2	4	4	3
Student 21	4	2	2	3	3	1	3	3	1	3	4	1	4	3	2	4	4	3
Student 22	4	2	1	3	3	1	3	3	1	3	4	1	3	3	2	4	4	1
Student 23	4	2	1	1	3	1	2	2	1	3	4	1	1	1	1	1	1	1
Student 24	4	2	1	3	3	1	3	3	2	3	4	1	3	4	2	3	3	1
Student 25	4	2	1	3	3	1	3	3	1	3	4	1	4	3	2	4	4	1
Student 26	4	2	2	3	3	1	3	3	2	3	4	1	4	3	1	4	4	1

	TASK NO. 1			TASK NO. 2			TASK NO. 3			TASK NO. 4			TASK NO. 5			TASK NO. 6		
	TEMPERATURE			RAINFALL			CYCLONE			DROUGHT			EXTREME METEOROLOGICAL CONDITION			GREENHOUSE GASES		
STUDENT NO.	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE
Student 27	4	2	2	3	3	2	3	3	1	3	3	1	4	3	2	4	4	1
Student 28	4	2	2	3	3	1	2	3	2	3	4	1	4	4	2	4	4	3
Student 29	4	2	2	3	3	2	3	3	2	3	4	1	4	3	2	3	3	1
Student 30	4	2	2	1	1	1	3	3	2	3	4	1	4	3	2	4	3	1
Student 31	4	2	2	3	3	2	3	3	2	3	3	2	4	4	2	4	3	2
Student 32	4	2	2	3	3	2	3	3	2	3	4	2	4	4	2	4	3	1
Student 33	4	2	2	3	2	1	3	1	2	3	1	2	4	3	1	3	4	2
Student 34	4	2	2	3	3	2	3	3	2	3	4	1	4	4	2	4	3	1
Student 35	4	2	2	3	2	1	3	3	2	3	4	2	4	4	1	3	3	2
Student 36	4	2	2	3	2	2	3	3	2	3	4	2	4	3	2	3	4	3
Student 37	4	2	2	3	3	4	3	3	1	3	4	3	4	3	1	3	4	2
Student 38	4	2	2	3	3	1	3	3	2	3	3	1	4	4	2	4	3	3
Student 39	4	2	2	3	3	1	3	3	1	3	4	1	4	3	2	4	3	2
Student 40	4	2	2	3	3	2	3	3	2	3	4	1	4	4	2	4	3	2
Student 41	4	2	1	3	3	1	3	3	1	3	4	1	4	3	2	4	3	2
Student 42	4	2	2	3	2	2	3	3	2	3	4	2	4	4	2	4	3	2
Student 43	4	2	2	3	2	2	3	3	2	3	4	2	4	3	2	4	3	2
Student 44	4	2	2	3	3	2	2	3	2	3	4	1	4	4	2	4	3	2
Student 45	4	2	2	3	3	2	2	3	2	3	4	1	4	4	2	4	3	2
Student 46	4	2	1	3	3	1	3	3	1	3	4	1	4	3	2	1	3	1
Student 47	4	2	2	2	3	1	3	3	2	3	4	1	4	3	1	1	1	1
Student 48	4	2	2	3	3	1	3	3	1	3	4	1	4	4	2	4	3	3
Student 49	4	4	2	3	3	2	3	3	1	3	4	1	4	3	2	3	3	2
Student 50	4	2	2	3	3	2	3	3	2	3	4	3	4	3	2	1	1	2
Student 51	4	2	1	3	3	1	3	3	2	3	1	1	4	2	2	1	3	2
Student 52	4	2	1	3	3	1	3	3	2	3	4	1	4	4	2	4	3	2

	TASK NO. 1			TASK NO. 2			TASK NO. 3			TASK NO. 4			TASK NO. 5			TASK NO. 6		
	TEMPERATURE			RAINFALL			CYCLONE			DROUGHT			EXTREME METEOROLOGICAL CONDITION			GREENHOUSE GASES		
STUDENT NO.	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE
Student 53	4	2	1	3	3	1	3	3	2	3	4	1	4	2	2	3	3	3
Student 54	4	4	2	3	3	2	3	3	2	3	4	1	4	3	2	3	3	2
Student 55	4	4	2	3	3	2	3	3	2	3	4	1	4	2	2	3	3	2
Student 56	4	2	2	3	2	1	3	3	2	1	1	3	4	3	1	4	3	2
Student 57	4	2	2	3	3	1	3	1	2	3	4	3	4	4	2	4	3	2
Student 58	3	2	1	2	3	1	1	1	2	3	4	1	4	4	1	4	3	2
Student 59	4	2	1	3	3	1	3	3	2	3	4	1	4	2	2	1	3	2
Student 60	4	2	1	1	3	1	3	3	2	3	4	1	1	1	1	4	3	2
Student 61	4	2	2	3	3	1	3	3	1	3	4	3	4	4	2	4	3	2
Student 62	4	2	1	3	3	1	4	4	1	3	4	1	4	3	1	3	3	1
Student 63	4	2	1	3	3	1	4	4	1	1	1	1	1	1	2	1	1	1
Student 64	4	2	2	4	3	1	3	3	1	1	1	1	1	1	2	1	1	1
Student 65	4	2	2	4	3	1	4	3	2	3	3	1	4	4	2	4	3	2
Student 66	4	4	2	4	3	1	4	4	2	3	4	1	4	3	2	1	4	2
Student 67	4	2	1	3	4	1	4	4	1	1	4	2	1	1	1	1	3	1
Student 68	4	2	1	1	1	1	4	4	2	1	1	1	1	3	1	1	1	1
Student 69	4	2	2	4	3	2	3	1	1	3	4	1	4	3	1	4	3	2
Student 70	4	2	2	3	3	1	4	4	2	3	4	1	4	3	2	3	4	2
Student 71	4	2	1	4	4	1	4	4	2	3	4	1	1	1	2	1	1	1
Student 72	4	2	2	3	3	1	4	3	2	3	1	1	4	1	2	3	3	2
Student 73	4	2	2	3	3	1	4	4	2	1	4	1	3	3	2	4	3	2
Student 74	4	2	2	4	2	2	4	4	1	3	4	1	4	4	2	4	3	1
Student 75	4	2	1	4	4	1	4	4	2	3	4	2	4	3	2	3	3	2
Student 76	4	2	1	3	3	1	3	3	1	1	1	1	4	1	2	1	1	1
Student 77	4	2	2	4	4	1	4	4	2	3	4	1	1	1	1	1	1	1
Student 78	4	2	2	4	4	1	1	1	2	3	4	2	4	3	2	4	3	2

	TASK NO. 1			TASK NO. 2			TASK NO. 3			TASK NO. 4			TASK NO. 5			TASK NO. 6		
	TEMPERATURE			RAINFALL			CYCLONE			DROUGHT			EXTREME METEOROLOGICAL CONDITION			GREENHOUSE GASES		
STUDENT NO.	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE
Student 79	4	2	2	2	3	1	3	2	2	3	4	1	1	1	2	3	3	1
Student 80	4	2	1	3	3	1	4	4	1	3	4	1	4	3	2	4	3	1
Student 81	1	1	2	3	3	1	1	1	1	1	1	1	1	1	2	4	1	1
Student 82	4	2	2	3	3	1	4	3	1	3	4	1	4	3	2	4	3	1
Student 83	4	2	2	4	3	1	4	3	1	3	4	1	4	3	2	4	3	2
Student 84	4	2	1	4	3	1	4	3	1	3	4	1	4	3	2	4	3	2
Student 85	4	2	1	3	3	1	4	4	2	3	4	1	1	1	2	4	3	1
Student 86	4	2	1	4	3	1	4	4	2	3	4	1	4	4	2	4	3	1
Student 87	3	2	1	3	3	1	3	3	2	1	1	1	4	4	2	4	3	2
Student 88	4	2	1	2	1	1	3	3	1	1	4	1	1	1	2	4	3	1
Student 89	4	2	1	4	3	2	4	4	1	3	4	1	4	3	2	4	3	1
Student 90	4	2	1	3	3	1	4	4	1	3	3	1	4	3	2	4	4	2
Student 91	4	2	2	1	2	1	3	3	2	3	4	1	1	1	2	3	4	2
Student 92	4	2	2	4	3	2	4	3	2	3	4	2	4	3	2	3	4	1
Student 93	4	2	1	3	3	1	3	3	1	3	4	2	1	3	2	4	3	2
Student 94	4	2	1	3	2	1	4	3	1	1	4	1	1	1	2	3	1	2
Student 95	4	2	2	2	3	1	4	3	1	3	4	1	4	3	2	4	4	2
Student 96	4	2	2	2	3	1	4	3	1	1	1	1	1	1	1	1	1	1
Student 97	4	2	2	4	4	1	3	3	2	3	4	2	4	3	2	4	4	2
Student 98	3	1	1	4	3	1	3	3	1	1	4	1	4	3	1	4	4	2
Student 99	4	2	1	3	3	1	3	3	1	3	4	1	4	3	2	1	1	1
Student 100	3	2	1	3	3	1	1	1	1	1	1	1	1	1	2	1	1	1
Student 101	4	2	1	3	3	1	1	3	1	1	4	1	1	3	1	4	3	1
Student 102	1	2	1	1	3	1	1	3	1	1	1	1	1	1	1	1	1	1
Student 103	4	2	1	4	3	1	1	3	2	1	4	1	1	1	1	1	1	1
Student 104	4	2	1	3	3	1	1	2	2	1	4	1	1	1	1	1	1	1

	TASK NO. 1			TASK NO. 2			TASK NO. 3			TASK NO. 4			TASK NO. 5			TASK NO. 6		
	TEMPERATURE			RAINFALL			CYCLONE			DROUGHT			EXTREME METEOROLOGICAL CONDITION			GREENHOUSE GASES		
STUDENT NO.	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE
Student 105	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 106	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1
Student 107	3	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 108	3	2	1	3	3	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 109	1	2	1	2	2	1	1	1	1	3	4	1	1	1	1	1	1	1
Student 110	4	2	1	2	3	1	2	2	1	1	1	1	1	1	1	1	1	1
Student 111	4	2	1	2	3	1	1	1	1	1	1	1	1	1	1	4	1	1
Student 112	1	2	1	1	3	1	2	2	1	1	4	1	1	1	1	1	1	1
Student 113	4	2	1	3	3	1	2	2	1	3	4	1	1	1	1	1	1	1
Student 114	1	2	1	2	3	1	2	2	1	1	4	1	1	3	2	1	1	1
Student 115	4	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 116	4	2	1	2	3	1	1	1	1	1	4	1	1	1	1	1	1	1
Student 117	4	2	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1
Student 118	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 119	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 120	1	2	1	1	3	1	1	2	1	1	4	1	1	3	1	3	3	1
Student 121	3	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 122	1	2	1	1	1	1	1	1	2	3	3	1	1	1	1	1	1	1
Student 123	4	2	1	3	3	1	1	1	1	1	3	1	1	1	1	1	1	1
Student 124	3	2	1	3	2	1	3	4	1	3	3	1	1	1	1	1	1	1
Student 125	4	2	1	1	3	1	2	2	1	1	4	1	1	3	1	1	3	1
Student 126	3	2	1	1	3	1	1	1	1	1	4	1	1	3	1	1	3	1
Student 127	4	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 128	4	2	1	2	3	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 129	4	2	1	2	3	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 130	4	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1

	TASK NO. 1			TASK NO. 2			TASK NO. 3			TASK NO. 4			TASK NO. 5			TASK NO. 6		
	TEMPERATURE			RAINFALL			CYCLONE			DROUGHT			EXTREME METEOROLOGICAL CONDITION			GREENHOUSE GASES		
STUDENT NO.	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE
Student 131	4	2	1	3	3	1	4	3	2	3	4	1	4	4	2	3	1	1
Student 132	4	2	1	2	3	1	1	1	1	1	1	1	1	1	2	1	1	1
Student 133	4	2	1	2	3	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 134	1	2	1	2	3	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 135	4	2	1	2	3	1	3	3	1	1	1	1	1	1	1	1	1	1
Student 136	4	2	1	2	3	1	4	4	1	3	4	1	2	2	1	1	1	1
Student 137	4	2	2	3	3	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 138	4	4	2	3	3	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 139	3	2	2	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 140	4	1	1	3	3	1	1	4	1	1	1	1	1	1	1	1	1	1
Student 141	4	2	1	3	3	2	1	3	1	1	1	1	1	1	1	1	1	1
Student 142	4	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 143	4	1	1	1	1	2	1	4	1	1	1	1	1	1	1	1	1	1
Student 144	4	2	1	2	2	1	3	4	1	3	4	1	1	1	1	1	1	1
Student 145	4	2	2	1	3	1	2	3	1	1	1	1	1	1	1	1	1	1
Student 146	4	2	1	1	1	1	4	4	1	3	1	1	1	3	1	1	1	1
Student 147	4	2	2	3	2	1	4	4	2	3	1	1	1	1	1	1	1	1
Student 148	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 149	4	1	2	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 150	4	2	2	2	3	1	1	3	2	3	1	1	3	2	1	3	3	1
Student 151	4	2	2	1	2	1	1	3	2	1	1	1	3	3	1	1	1	1
Student 152	1	2	2	1	3	1	1	3	2	3	3	1	1	1	1	3	3	1
Student 153	3	2	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1
Student 154	1	2	1	1	3	2	1	3	1	1	1	1	1	1	1	1	1	1
Student 155	1	2	1	3	3	1	4	3	1	1	1	1	1	1	1	1	1	1
Student 156	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1

	TASK NO. 1			TASK NO. 2			TASK NO. 3			TASK NO. 4			TASK NO. 5			TASK NO. 6		
	TEMPERATURE			RAINFALL			CYCLONE			DROUGHT			EXTREME METEOROLOGICAL CONDITION			GREENHOUSE GASES		
STUDENT NO.	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE
Student 157	3	2	1	1	3	1	1	3	1	1	1	1	1	1	1	1	1	1
Student 158	3	3	2	3	3	1	3	3	2	1	4	1	1	1	1	1	1	1
Student 159	2	2	1	1	3	1	1	1	1	3	4	1	1	3	1	1	1	1
Student 160	1	2	2	3	1	1	4	3	1	1	1	1	1	1	1	1	1	1
Student 161	3	2	2	4	3	1	4	4	1	3	4	1	1	1	1	3	3	1
Student 162	4	2	1	4	3	1	4	4	1	3	4	1	1	1	2	1	1	2
Student 163	3	2	2	1	1	1	1	1	2	3	1	1	1	1	1	1	1	1
Student 164	4	2	2	3	3	1	3	3	1	1	1	1	1	1	1	1	1	1
Student 165	4	1	2	1	3	1	2	3	1	3	4	1	4	4	1	3	1	1
Student 166	4	2	1	1	3	1	1	1	1	3	4	1	4	3	1	4	4	1
Student 167	4	2	1	3	1	1	3	4	1	3	1	1	1	1	1	1	1	1
Student 168	4	2	1	1	3	1	2	3	1	3	4	1	1	3	1	3	1	1
Student 169	1	2	1	1	3	1	1	3	1	3	4	1	1	3	1	1	1	1
Student 170	2	2	2	1	3	1	1	3	1	1	1	1	1	1	2	1	1	1
Student 171	3	2	2	1	3	2	1	1	1	1	4	1	1	3	1	1	1	1
Student 172	2	2	2	2	3	1	2	3	1	1	1	1	1	1	1	1	1	1
Student 173	2	2	2	3	3	1	3	3	1	1	1	1	1	1	1	1	1	1
Student 174	3	2	1	1	3	1	3	3	1	1	1	1	1	1	1	1	1	1
Student 175	3	2	1	1	3	1	1	3	1	3	4	1	1	3	1	1	3	1
Student 176	2	2	2	2	2	1	3	3	1	3	3	1	1	1	1	3	4	1
Student 177	4	2	1	2	3	1	4	1	1	3	1	1	4	3	1	3	3	1
Student 178	4	2	2	1	3	1	4	3	2	3	4	1	4	3	1	1	1	1
Student 179	1	2	1	1	1	1	1	3	1	1	1	1	4	3	1	1	1	1
Student 180	4	2	1	1	3	1	1	3	1	3	1	1	1	1	1	1	1	1
Student 181	4	2	1	3	2	1	3	4	1	1	1	1	1	1	1	1	1	1
Student 182	4	1	2	1	3	1	1	3	1	3	1	1	4	3	1	1	1	1

	TASK NO. 1			TASK NO. 2			TASK NO. 3			TASK NO. 4			TASK NO. 5			TASK NO. 6		
	TEMPERATURE			RAINFALL			CYCLONE			DROUGHT			EXTREME METEOROLOGICAL CONDITION			GREENHOUSE GASES		
STUDENT NO.	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE
Student 183	2	2	2	3	3	1	1	3	2	1	4	1	1	3	1	1	1	3
Student 184	4	2	2	2	3	1	4	4	1	3	1	1	1	3	1	3	1	1
Student 185	4	2	2	2	3	1	1	1	1	3	4	1	4	3	1	4	3	2
Student 186	2	2	2	1	3	1	3	3	2	3	1	1	1	1	1	1	1	1
Student 187	3	2	2	1	3	1	1	3	2	1	1	1	1	1	1	1	1	1
Student 188	4	1	2	1	3	1	1	3	1	3	4	1	4	4	2	4	4	1
Student 189	3	2	2	2	3	1	1	1	1	1	1	1	1	1	1	4	3	1
Student 190	4	2	1	3	1	1	1	1	2	1	4	1	1	1	2	1	1	3
Student 191	4	2	1	3	1	1	1	1	2	1	1	1	1	1	1	1	1	1
Student 192	1	2	2	1	1	1	1	3	1	1	1	1	1	3	1	1	1	1
Student 193	4	2	2	1	3	2	1	1	1	1	1	1	1	1	1	1	1	2
Student 194	2	2	2	1	3	1	1	3	1	3	4	1	3	2	2	3	3	1
Student 195	4	2	1	1	3	1	1	3	1	1	1	1	1	1	2	1	1	2
Student 196	2	2	2	3	3	2	4	4	1	1	4	1	1	3	2	1	1	1
Student 197	1	2	2	3	3	1	1	3	1	1	1	1	1	1	1	1	3	1
Student 198	2	2	2	3	3	1	1	3	1	1	4	1	1	3	1	3	4	1
Student 199	2	2	2	3	3	1	1	3	2	1	4	1	1	3	2	3	4	3
Student 200	4	2	2	1	3	1	1	3	1	3	4	1	1	3	2	3	3	1
Student 201	4	2	2	2	3	1	1	3	1	1	4	1	1	1	1	1	1	1
Student 202	4	2	1	2	3	1	1	3	1	1	4	1	1	3	1	4	3	1
Student 203	4	2	1	3	3	1	1	3	1	1	4	1	4	4	2	4	3	1
Student 204	4	2	2	3	3	1	1	3	1	1	4	1	1	3	1	1	4	1
Student 205	4	2	1	1	2	1	1	1	1	3	4	1	3	2	1	3	3	1
Student 206	4	2	1	1	3	1	1	3	1	3	4	1	3	2	1	1	1	1
Student 207	4	2	1	1	3	1	1	1	1	1	4	1	1	3	1	3	3	1
Student 208	4	2	1	1	3	2	1	1	1	1	4	1	4	4	1	3	3	1

	TASK NO. 1			TASK NO. 2			TASK NO. 3			TASK NO. 4			TASK NO. 5			TASK NO. 6		
	TEMPERATURE			RAINFALL			CYCLONE			DROUGHT			EXTREME METEOROLOGICAL CONDITION			GREENHOUSE GASES		
STUDENT NO.	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE	CAUSE	EFFECT	IMAGE
Student 208	4	2	1	1	3	2	1	1	1	1	4	1	4	4	1	3	3	1
Student 209	4	2	1	3	1	1	1	3	1	1	1	1	1	1	1	1	1	1
Student 210	4	2	1	1	3	1	1	1	1	1	1	2	1	1	1	1	1	1
Student 211	4	2	1	1	3	1	1	3	1	1	4	1	1	1	1	1	1	1
Student 212	4	2	2	3	3	1	1	4	1	3	4	1	1	1	1	1	1	2
Student 213	4	2	2	1	3	1	1	3	1	1	1	1	1	2	1	1	1	2
Student 214	2	2	2	3	3	2	2	2	2	1	4	2	1	1	2	1	1	1
Student 215	4	2	2	2	3	1	4	4	2	1	1	2	1	1	2	3	3	1
Student 216	4	2	1	2	1	1	2	3	2	3	1	1	4	1	1	4	3	1
Student 217	2	1	1	3	3	1	2	1	2	1	1	2	1	1	2	1	1	3
Student 218	4	2	1	2	3	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 219	4	3	2	2	2	1	1	1	1	1	4	1	1	1	1	1	4	2
Student 220	4	2	1	2	2	1	1	3	1	1	1	1	1	3	2	3	3	1
Student 221	4	2	2	3	3	1	1	3	1	1	1	1	1	1	1	1	1	1
Student 222	4	2	1	2	3	1	1	1	1	3	1	1	1	3	2	1	3	1
Student 223	4	2	2	2	3	1	1	3	1	1	1	1	1	1	1	4	4	3
Student 224	4	1	1	2	3	1	1	3	1	1	1	1	1	1	1	1	1	1
	781	**460**	**334**	**523**	**600**	**262**	**508**	**583**	**301**	**468**	**625**	**254**	**507**	**481**	**322**	**513**	**490**	**320**
Average	**3.49**	**2.05**	**1.49**	**2.33**	**2.68**	**1.17**	**2.27**	**2.60**	**1.34**	**2.09**	**2.79**	**1.13**	**2.26**	**2.15**	**1.44**	**2.29**	**2.19**	**1.43**
SD	**0.993**	**0.550**	**0.501**	**0.979**	**0.724**	**0.432**	**1.167**	**1.001**	**0.476**	**0.998**	**1.425**	**0.413**	**1.445**	**1.129**	**0.497**	**1.359**	**1.194**	**0.659**
Pearson (r)	**0.112**	**0.279**	**0.240**	**0.141**	**0.032**	**0.349**	**0.310**	**0.194**	**0.609**	**0.145**	**0.109**	**0.552**	**0.532**	**0.452**	**0.746**	**0.441**	**0.496**	**0.792**
	C vs I	E vs I	C vs E	C vs I	E vs I	C vs E	C vs I	E vs I	C vs E	C vs I	E vs I	C vs E	C vs I	E vs I	C vs E	C vs I	E vs I	C vs E

APPENDIX D

Adapted and Revised Scoring Rubric

Scoring Guide for Students' Response
on the Conceptual Understanding and Image Task Instruments on Climate Change

The matrix below shows the scoring guide for the use of the Conceptual Understanding and Image Task Instruments about the different concepts on climate change. The concepts on climate change are according to recommendations from Philippine Atmospheric Geophysical & Astronomical Services Administration (PAGASA) including the suggestions from experts of Department of Environment and Natural Resources (DENR). The description of conceptual understanding and images are patterned from Kozma and Russel (2005).

Scoring Guide for Students' Conceptual Understanding on the Concepts on Climate Change:

Tasks	Sound Understanding	Partial Understanding	Specific Misconception	No Understanding	No Response
Explain or discuss the causes and effects of temperature in the formation of rain.	The students write either cause of increase of temperature due to man-made or anthropogenic activities but include the natural occurring factors affecting the temperature. The students write the effects of increase of temperature to the rate of precipitation such as above normal rainfall but also it may cause no rainfall in some areas.	The students write the causes of increase of temperature due to man-made or anthropogenic activities only. The students write the effects of increase of temperature to the rate of precipitation such as heavy rainfall, super typhoon etc. but contain incorrect or illogical information.	The students simply write either cause of increase of temperature including anthropogenic or man-made activities and the effect to the rate of precipitation but incorrect or illogical information.	The students' concept is irrelevant to the question.	The students write the concepts that may depict they have no idea about it.

Tasks	Sound Understanding	Partial Understanding	Specific Misconception	No Understanding	No Response
Explain or discuss the causes and effects of rainfall abnormalities that may be attributed to "habagat."	The students write the causes of excessive precipitation or above normal rainfall due to anthropogenic or man-made activities but include natural occurring factors affecting rainfall. The students write effects of heavy rainfall especially to urban area and by mentioning that there are some effects of heavy rainfall that is not due to climate change such as poor drainage system, etc.	The students write the causes of excessive precipitation or above normal rainfall due to man-made or anthropogenic activities. The students write the effects of excessive rainfall to urban areas such as storm surges, rising of sea level etc. but contain incorrect or illogical information.	The students simply write either the cause of excessive precipitation due to man-made anthropogenic activities or the possible effects especially to urban area but incorrect or illogical information.	The students' concept is irrelevant to the question.	The students write the concepts that may depict they have no idea about it.

Tasks	Sound Understanding	Partial Understanding	Specific Misconception	No Understanding	No Response
Explain or discuss the causes and effects of formation of tropical cyclones.	The students write the causes of increase of number of tropical cyclone both man-made anthropogenic activities and the natural occurring factors causing tropical cyclones. The students write the effects to the economy, education, nature, jobs, lifestyle, etc. but the students also determine that these effects are not only due to the climate change but also due to lack of education and lack of undisciplined citizens.	The students write the causes of increase of number of tropical cyclone due to man-made or anthropogenic activities. The students write effects to the economy, education, nature, jobs, lifestyle, etc. such as heavy flood, destruction of properties etc.	The students simply write causes of increase of tropical cyclone but incorrect or illogical information. The students write the effects of experiencing tropical cyclones to economy, education, nature, jobs, lifestyle, etc. but incorrect or illogical information.	The student's concept is irrelevant to the question.	The students write the concepts that may depict they have no idea about it.

Tasks	Sound Understanding	Partial Understanding	Specific Misconception	No Understanding	No Response
Explain or discuss the causes and effects of drought phenomenon.	The students write the cause of El Niño to man-made or anthropogenic activities including the natural occurring phenomenon due to trade winds blows from East to West. The students write the effects of El Niño such lesser precipitation, affects agricultural sector but it also brings heavy rainfall or affect rainfall patterns in other part of the world.	The students write either the cause of El Niño due to climate change and global warming due to man-made or anthropogenic activities and also it is natural occurring phenomenon but failed to explain how it happens. The students write the effects of drought such as shortage of water, affect the agricultural sector and increase of temperature etc.	The students simply write cause of El Niño due to global warming or climate change or simply write examples of anthropogenic activities that caused global warming and the effects of El Niño such as lesser precipitation or no rain, shortage of water, affects the agricultural sector but incorrect or illogical information.	The student's concept is irrelevant to the question.	The students write the concepts that may depict they have no idea about it.

Tasks	Sound Understanding	Partial Understanding	Specific Misconception	No Understanding	No Response
Explain or discuss the causes and effects of extreme meteorological events	The students write the possible causes of extreme metrological event due to man-made or anthropogenic activities such as increase in temperature due to global warming but also natural causes. The students write the possible effects of extreme meteorological condition such as: a. increase number of typhoons b. stronger typhoons c. storm surge d. extreme temperature The students write the effects of extreme weather condition also due to natural causes. Extreme weather can happen with or without climate change but that there is evidence that human influence has substantially caused extreme conditions.	The students write either the possible causes of extreme metrological event due man-made or anthropogenic activities such as increase in temperature due to global warming, etc. The students write the possible effects of extreme meteorological condition such as: a. increase number of typhoons b. stronger typhoons c. storm surge d. extreme temperature	The students simply write the possible causes of extreme metrological condition. According to Choi, et al., 2009, common students' misconception climate change is only limited to warming in general. Not understanding on the feedbacks of climate change. The students write the common effects of extreme meteorological condition such as: a. flood b. destroy properties c. death	The student's concept is irrelevant to the question	The students write the concepts that may depict they have no idea about it.

Tasks	Sound Understanding	Partial Understanding	Specific Misconception	No Understanding	No Response
Explain or discuss the causes and effects of increase of rate of greenhouse gases.	The students write either the natural and anthropogenic causes of accumulation of greenhouses in atmosphere due to man-made or anthropogenic activities including the natural causes of greenhouse effect and its importance. The students write the possible effects of increase of greenhouse gases such as increase of temperature that result occurrence of extreme weather conditions such super typhoon etc.	The students write either the natural and anthropogenic causes of accumulation of greenhouses in atmosphere due to man-made or anthropogenic activities. The students write the possible effects of increase of greenhouse gases such as global warming, melting of ice, changing of climates and seasons etc. but may contain specific misconception like this is only due to man-made activities..	The students simply write the causes of accumulation of greenhouse gases but incorrect or illogical information. The students simply write the effects of increase of accumulation of greenhouse gases in the atmosphere but incorrect or illogical information.	The student's concept is irrelevant to the question.	The students write the concepts that may depict they have no idea about it.

Conceptual understanding and their corresponding descriptions adapted from Kozma and Russel (2005).

Definition and Description
Sound Understanding - responses of the students includes all components or some of the scientifically accepted response.
Partial Understanding – responses of the students may include at least one of the components of the acceptable scientific ideas; and that show understanding of concepts but that may also contain a kind of misconception.
Specific Misconception – students' response may include descriptive, incorrect or illogical information.
No Understanding – students' response is part of, or full form of the question or task; or it may be any irrelevant or uncodable responses; or of a phrase like *"I don't understand."*
No response – students may have no answer or have the following forms and the likes of responses:*"No answer," "I don't know," "I have no idea."*

Scoring Guide for Students' Images on the Concepts on Climate Change:

Tasks	Reflective and Rhetorical	Semantic	Syntactic	Symbolic	Depiction
The students use images illustrating the concept in the process of the formation of rain through the water cycle.	The students use images by illustrating the concept in the process of the formation of rain through the water cycle. The image illustrates some examples of man-made activities that cause increase of temperature affecting the rate of precipitation.	The students use images illustrating the concept in the process of the formation of rain through the water cycle. The image illustrates the effect to the rate of precipitation when there is presence of low or high temperature such as an image of heat coming from the sun.	The students have illustrated an image representing the concept of formation of rain through the water cycle by using symbols such as clouds, raindrops, body of water, and sun. The image illustrates the effect to the rate of precipitation when there is a presence of temperature.	The students have illustrated an image representing the concepts of the formation of rain in the presence of temperature. Symbols were used by students in demonstrating the evaporation or precipitation.	Illustrate the concept of the formation of rain when temperature is present. It may depict that they have no idea about it.

Tasks	Reflective and Rhetorical	Semantic	Syntactic	Symbolic	Depiction
Illustrate the concept of southwest monsoon commonly called as “habagat” affecting heavy rainfall.	The students use images illustrating the difference between northeast monsoon or "amihan" and southwest monsoon or “habagat” of climate change. The students also use an illustration or image explaining each type of monsoon, including its present situation due to the effect of climate change because of anthropogenic activities. Also illustrating the natural causes of monsoon.	The students use images illustrating the concept of southwest monsoon or “habagat”. The illustration or image indicates that a southwest monsoon or "habagat" causes abundant rainfall or even a flood. The students also use the concept of formal symbols of the following (e.g. CO_2, O_2, O_3, etc.)	The students use images illustrating the concept of southwest monsoon or “habagat”. The illustration or image indicates that a southwest monsoon or "habagat" causes abundant rainfall then resulted to flood while "amihan" is characterized by moderate temperatures, little or no rain. The students also illustrate factors affecting evaporation and precipitation etc. (e.g. when heat is present)	The students have illustrated an image representing the concepts on southwest monsoon “habagat” which causes heavy rainfall while "amihan" is characterized by moderate temperatures, little or no rain. Symbols were used by students in illustrating the concept on southwest monsoon "habagat" and northeast monsoon "amihan"	The students have illustrated an image representing the concepts of southwest monsoon “habagat” and concepts on northeast monsoon "amihan". It also may depict that they have no idea about it.

Tasks	Reflective and Rhetorical	Semantic	Syntactic	Symbolic	Depiction
Illustrate the concept of the formation of tropical cyclones in the Pacific Ocean.	The students use images illustrating the process of formation of tropical cyclone and demonstrating the different categories of tropical cyclones in the Philippines. The increase of temperature in the ocean also affect the formation of tropical cyclone aside from the location of the Philippines.	The students use images illustrating the process of formation of tropical cyclone starting from the Pacific Ocean and demonstrate the different categories of tropical cyclones. The illustration or image demonstrates that mostly Philippines is affected due to its geographical location and other anthropogenic activities.	The students use images illustrating the concept of the formation of tropical cyclones in the Pacific Ocean. The illustration or image demonstrates the different categories of tropical cyclones in the Philippines.	The students have illustrated an image representing the concepts on the formation of tropical cyclones. Symbols were used by the students in illustrating the concept on tropical cyclones.	The students have illustrated an image representing the concepts on the process of formation of tropical cyclones. It may depict that they have no idea about it.

Tasks	Reflective and Rhetorical	Semantic	Syntactic	Symbolic	Depiction
Illustrate the concept of drought specifically El Niño phenomenon.	The students use images by illustrating the concept of the formation of drought. The student can explain the difference of El Niño from La Niña. It demonstrates the effect of El Niño due to climate change.	The students have illustrated an image representing the concepts of cause of drought that occurs in the Pacific Ocean due to temperature and its effect to the environment due to anthropogenic activities.	The students have illustrated an image representing the concepts of cause of drought that occurs in the Pacific Ocean due to temperature and its effect to the environment.	The students have illustrated an image representing the concepts of cause of drought that occurs in the Pacific Ocean due to temperature. Symbols were used by the students demonstrating the concept of drought.	The students have illustrated an image representing the concepts of drought. It may depict that they have no idea about it.
Illustrate the concept of extreme meteorological events.	The students use images by illustrating the concept of man-made or anthropogenic activities resulting to threatening meteorological events. The students can differentiate the difference between man-made and natural cause of climate change.	The students use images illustrating the concept of man-made or anthropogenic activities which are the possible cause effect of meteorological events by giving example of meteorological events. The illustration or image uses formal symbols.	The students use images illustrating the concept of man-made made or anthropogenic activities which causes of the development of meteorological events. The illustration or image demonstrates the effect of these man-made activities affecting the climate.	The students have illustrated an image of man-made or anthropogenic activities representing the concepts of meteorological events. Symbols were used by the students demonstrating the concept of the development of meteorological events.	The students have illustrated an image representing the concepts of man-made (anthropogenic) activities which causes the development of threatening meteorological events. It may depict that they have no idea about it.

Tasks	Reflective and Rhetorical	Semantic	Syntactic	Symbolic	Depiction
Illustrate the concepts of increase of greenhouse gases	The students use images illustrating the concept of greenhouse gases. They can differentiate the difference between man-made and natural cause of increase of greenhouse gases in the atmosphere. It demonstrates the effect if there is an increase of greenhouse gases in the rate of climate change.	The students use images illustrating the concept of increase of greenhouse gases in the atmosphere. The illustration or image demonstrates the usefulness of greenhouse gases, but also the disadvantage if there is an increase of greenhouse gases in the atmosphere. The students uses formal symbol.	The students use images illustrating the concept of the increase of greenhouse gases. The illustration or image demonstrates the cause and effect of accumulation of greenhouse gases due to man-made activities.	The students have illustrated an image representing the concepts of causes of accumulation of greenhouse gases in the atmosphere due to anthropogenic activities. Symbols were used by the students demonstrating the concept of the greenhouse effect.	The students have illustrated an image representing the concepts of causes of accumulation of greenhouse gases in the atmosphere. It may depict that they have no idea about it.

Students' Images and their corresponding descriptions adapted from Kozma and Russel (2005).

Definition and Description
Reflective and Rhetorical – students can explain the relationship between physical attributes and underlying process and can use one or more representation or images on the climate change.
Semantic – students generate a representation or images on climate change by using formal symbol to represent underlying non-observable processes.
Syntactic – students generate a representation or images on climate change both observed and unobserved physical attributes.
Symbolic – students generate a representation or images on climate change based on physical attributes but include symbols.
Depiction – students generate a representation or images on climate change based on their physical attributes.

APPENDIX E

Task Instrument and Scoring Rubric Validation Checklist

Appendix E1

Evaluation Checklist for the Validation of the Conceptual Understanding and Image Task Instrument on Climate Change

Part I. ***Personal Profile Form of the Evaluator***

Direction: *Please fill in the necessary information asked in the questionnaire by supplying data or by checking the item in the space provided for each item.*

Name: _____ Gender: _____

Present Position /Rank: _____ Years of Teaching Experience: _____

University or Agency Affiliation: _____ Subjects Taught: _____

Highest Educational Attainment:

_____ Doctorate Degree
_____ Master's Degree with PhD Units
_____ Master's Degree
_____ Bachelor's Degree with MA units
_____ Bachelor's Degree

Specialization _____

Part II. ***Evaluation Checklist***

Direction: *Please put a check mark on your assessment on the level of acceptability of the task instruments on climate change based on the following criteria. This task instrument will be conducted to Grade 10 high school students.*

Scale	***Interpretation***	***Description***
5	Very Acceptable	The statement is high evident in the developed task instruments on climate change
4	Acceptable	The statement is evident in the developed task instruments on climate change
3	Moderately Acceptable	The statement is somehow evident in the developed task instruments on climate change
2	Least Acceptable	The statement is not that evident in the developed task instruments on climate change
1	Not Acceptable	The statement is really not evident in the developed task instruments on climate change

DIRECTION: *Below is a list of different criteria to test the validity of the rubrics that will be used in assessing the students' conceptual understanding and images on climate change. Kindly check (/) the box that corresponds to your assessment of the scoring rubric.*

CONTENT VALIDITY OF TASK INSTRUMENT	**5**	**4**	**3**	**2**	**1**
a. enables the students to reflect their own on the different concepts on climate change.					
b. enables the students to reflect their own images about the different concepts on climate change.					
c. contains concepts that are based on the competencies of Grade 10 students.					
d. contains concepts that are easy to understand without confusing information.					
e. contains contents which are appropriate for the students' cognitive level.					
f. is thought-provoking and requires the usage of relevant science process skills					
g. gives information to assess students' prior concepts.					
h. uses languages in proper context.					
i. gives instructions that are easy to follow.					
j. clearly provides a pointing system through a rubric.					

FACE VALIDITY OF TASK INSTRUMENT	**5**	**4**	**3**	**2**	**1**
a. has enough space provided for the respondents' responses and illustrations.					
b. has clear and organized layout.					
c. uses rubric in giving equivalent weight for each item.					
d. use familiar type tasks.					
e. is free of grammar and spelling errors					
f. has a clear instruction, purpose and personal profile for the respondents.					

COMMENTS AND SUGGESTIONS:

_____
_____
_____

_____
Signature over Printed Name of the Evaluator

Appendix E2

Evaluation Checklist for the Validation of the Conceptual Understanding and Image Task Instrument on Climate Change

Part I. ***Personal Profile Form of the Evaluator***

Direction: *Please fill in the necessary information asked in the questionnaire by supplying data or by checking the item in the space provided for each item.*

Name: [redacted]

Gender: F

Present Position /Rank: Professor - De La Salle Araneta University

Years of Teaching Experience: 15 years

University or Agency Affiliation: ______

Subjects Taught: Marine and Terrestrial Ecology; Recent Advances in Animal Nutrition; Environmental Management; Animal Hygiene and Sanitation; Animal Growth and Adaptation; Feeds and Feeding Management; Soil Science; Rural Extension; Plant Pathology; Agricultural Processes and Economics; Statistics and Research; Teaching of Biology; Graduate Seminar; HAPSAM; Systematics and evolution; Terrestrial Ecology; Biology I & II; Curriculum Design; Statistics for Nursing & Business;

Highest Educational Attainment:

✓ Doctorate Degree
______ Master's Degree with PhD Units
______ Master's Degree
______ Bachelor's Degree with MA units
______ Bachelor's Degree

Specialization: Horticulture

Part II. ***Evaluation Checklist***

Direction: *Please put a check mark on your assessment on the level of acceptability of the task instruments on climate change based on the following criteria. This task instrument will be conducted to Grade 10 high school students.*

Scale	*Interpretation*	*Description*
5	Very Acceptable	The statement is high evident in the developed task instruments on climate change
4	Acceptable	The statement is evident in the developed task instruments on climate change
3	Moderately Acceptable	The statement is somehow evident in the developed task instruments on climate change
2	Least Acceptable	The statement is not that evident in the developed task instruments on climate change
1	Not Acceptable	The statement is really not evident in the developed task instruments on climate change

DIRECTION: *Below is a list of different criteria to test the validity of the rubrics that will be used in assessing the students' conceptual understanding and images on climate change. Kindly check (/) the box that corresponds to your assessment of the scoring rubric.*

CONTENT VALIDITY OF TASK INSTRUMENT	5	4	3	2	1
a. enables the students to reflect their own on the different concepts on climate change.	/				
b. enables the students to reflect their own images about the different concepts on climate change.	/				
c. contains concepts that are based on the competencies of Grade 10 students.		/			
d. contains concepts that are easy to understand without confusing information.		/			
e. contains contents which are appropriate for the students' cognitive level.		/			
f. is thought-provoking and requires the usage of relevant science process skills		/			
g. gives information to assess students' prior concepts.		/			
h. uses languages in proper context.		/			
i. gives instructions that are easy to follow.		/			
j. clearly provides a pointing system through a rubric.	/				

FACE VALIDITY OF TASK INSTRUMENT	5	4	3	2	1
a. has enough space provided for the respondents' responses and illustrations.	/				
b. has clear and organized layout.		/			
c. uses rubric in giving equivalent weight for each item.	/				
d. use familiar type tasks.		/			
e. is free of grammar and spelling errors		/			
f. has a clear instruction, purpose and personal profile for the respondents.		/			

COMMENTS AND SUGGESTIONS:

can i have a feedback if the instrument will have translations in "vernacular" ??? this is rather good instrument for an important research...

SO[redacted]NJA

Signature over Printed Name of the Evaluator

Appendix E3

Evaluation Checklist for the Validation of the Conceptual Understanding and Image Task Instrument on Climate Change

Part I. ***Personal Profile Form of the Evaluator***

Direction: *Please fill in the necessary information asked in the questionnaire by supplying data or by checking the item in the space provided for each item.*

Name: [redacted] Gender: M

Present Position /Rank: EMS Years of Teaching Experience: 1 year

University or Agency Affiliation: EMB - Climate Change Division Subjects Taught: Biology & Environmental Science

Highest Educational Attainment:

___ Doctorate Degree
___ Master's Degree with PhD Units
✓ Master's Degree
___ Bachelor's Degree with MA units
___ Bachelor's Degree

Specialization Biology

Part II. ***Evaluation Checklist***

Direction: *Please put a check mark on your assessment on the level of acceptability of the task instruments on climate change based on the following criteria. This task instrument will be conducted to Grade 10 high school students.*

Scale	*Interpretation*	*Description*
5	Very Acceptable	The statement is high evident in the developed task instruments on climate change
4	Acceptable	The statement is evident in the developed task instruments on climate change
3	Moderately Acceptable	The statement is somehow evident in the developed task instruments on climate change
2	Least Acceptable	The statement is not that evident in the developed task instruments on climate change,
1	Not Acceptable	The statement is really not evident in the developed task instruments on climate change

DIRECTION: *Below is a list of different criteria to test the validity of the rubrics that will be used in assessing the students' conceptual understanding and images on climate change. Kindly check (/) the box that corresponds to your assessment of the scoring rubric.*

CONTENT VALIDITY OF TASK INSTRUMENT	5	4	3	2	1
a. enables the students to reflect their own on the different concepts on climate change.	/				
b. enables the students to reflect their own images about the different concepts on climate change.	/				
c. contains concepts that are based on the competencies of Grade 10 students.	/				
d. contains concepts that are easy to understand without confusing information.		/			
e. contains contents which are appropriate for the students' cognitive level.		/			
f. is thought-provoking and requires the usage of relevant science process skills			/		
g. gives information to assess students' prior concepts.	/				
h. uses languages in proper context.	/				
i. gives instructions that are easy to follow.	/				
j. clearly provides a pointing system through a rubric.	/				

FACE VALIDITY OF TASK INSTRUMENT	5	4	3	2	1
a. has enough space provided for the respondents' responses and illustrations.	/				
b. has clear and organized layout.	*	/			
c. uses rubric in giving equivalent weight for each item.		/			
d. use familiar type tasks.		/			
e. is free of grammar and spelling errors		/			
f. has a clear instruction, purpose and personal profile for the respondents.		/			

COMMENTS AND SUGGESTIONS:

The material does not include metrics to measure the respondent's understanding on the difference of natural climate variability and Climate change as well as natural Greenhouse effect and human Induced Greenhouse effect.

[redacted]
Signature over Printed Name of the Evaluator

Appendix E4

Evaluation Checklist for the Validation of the Conceptual Understanding and Image Task Instrument on Climate Change

Part I. ***Personal Profile Form of the Evaluator***

Direction: *Please fill in the necessary information asked in the questionnaire by supplying data or by checking the item in the space provided for each item.*

Name: [redacted] JOE >

~~Sex~~ ~~Gender~~: F

Present Position /Rank: INSTRUCTOR I

Years of Teaching Experience: 9

University or Agency Affiliation: PHILIPPINE NORMAL UNIVERSITY

Subjects Taught: BIOLOGY & EARTH SCIENCE

Highest Educational Attainment:

_____ Doctorate Degree
_____ Master's Degree with PhD Units
__✓__ Master's Degree
_____ Bachelor's Degree with MA units
_____ Bachelor's Degree

Specialization BIOLOGICAL SCIENCE

Part II. ***Evaluation Checklist***

Direction: *Please put a check mark on your assessment on the level of acceptability of the task instruments on climate change based on the following criteria. This task instrument will be conducted to Grade 10 high school students.*

Scale	*Interpretation*	*Description*
5	Very Acceptable	The statement is high evident in the developed task instruments on climate change
4	Acceptable	The statement is evident in the developed task instruments on climate change
3	Moderately Acceptable	The statement is somehow evident in the developed task instruments on climate change
2	Least Acceptable	The statement is not that evident in the developed task instruments on climate change
1	Not Acceptable	The statement is really not evident in the developed task instruments on climate change

DIRECTION: *Below is a list of different criteria to test the validity of the rubrics that will be used in assessing the students' conceptual understanding and images on climate change. Kindly check (/) the box that corresponds to your assessment of the scoring rubric.*

CONTENT VALIDITY OF TASK INSTRUMENT	5	4	3	2	1
a. enables the students to reflect their own on the different concepts on climate change.	✓				
b. enables the students to reflect their own images about the different concepts on climate change.	✓				
c. contains concepts that are based on the competencies of Grade 10 students.	✓				
d. contains concepts that are easy to understand without confusing information.	✓				
e. contains contents which are appropriate for the students' cognitive level.	✓				
f. is thought-provoking and requires the usage of relevant science process skills	✓				
g. gives information to assess students' prior concepts.		✓			
h. uses languages in proper context.		✓			
i. gives instructions that are easy to follow.	✓				
j. clearly provides a pointing system through a rubric.		✓			

FACE VALIDITY OF TASK INSTRUMENT	5	4	3	2	1
a. has enough space provided for the respondents' responses and illustrations.	✓				
b. has clear and organized layout.	✓				
c. uses rubric in giving equivalent weight for each item.			✓		
d. use familiar type tasks.	✓				
e. is free of grammar and spelling errors		✓	✓		
f. has a clear instruction, purpose and personal profile for the respondents.	✓	✓			

COMMENTS AND SUGGESTIONS:

please see the instrument for comments on selected items.

[redacted]

Signature over Printed Name of the Evaluator

APPENDIX F
Letter for Validation

Appendix F1

Communication Letter

November 11, 2015

_____
_____
_____

Dear _____,

The undersigned is a MASE General Science student from Philippine Normal University and presently conducting a research entitled *"Explain and Illustrate Task Instrument: Assessing Students' Conceptual Understanding and Images on Climate Change"*. The primary purpose of the said research undertaking is to investigate the students' conceptual understanding and images about the different concepts on climate change.

In line with the completion of the study, is the development and validation of task instrument together with its scoring guide in order to realize the objectives of the said research study. It is in this light that the undersigned would like to ask for your expertise and assistance for the initial validation phase of the research instrument and scoring guide. Your comments and suggestions are highly and constructively appreciated for its betterment as your expertise and inclination on the field are the most reliable source of ideas and supplements deemed necessary for the accuracy and suitability of the research instrument to be used.

Attached to this communication are the task instruments, scoring guide and evaluation checklist for the validation process. Thank you in advance for your positive response as you share your time and sharing expertise in research endeavor.

Respectfully yours,

(Sgd) Ms. Rosyl C. Salinas
Researcher

Noted by:

(Sgd) Mr. Brando C. Palomar
Research Adviser

APPENDIX G

Letter for Approval

Appendix G1

Communication Letter

January 26, 2016

_____
_____
_____

Dear _____,

The undersigned is a MASE General Science student of Philippine Normal University and presently conducting a research entitled *"Explain and Illustrate Task Instrument: Assessing Students' Conceptual Understanding and Images on Climate Change"*. The primary purpose of the research undertaking is to probe students' conceptual understanding and images on the different concepts of climate change.

In line with the above-mentioned undertaking, the undersigned would like to request from your good office the approval to allow the administration of the research instrument at Valenzuela National High School. If approval is granted, at least two (2) sections from Grade ten (10) students who will be chosen as the respondents to answer the task instrument on the recommended schedule. The instrument administration will be conducted by the researcher and will be observed for about 45 minutes. Rest assured that responses and data results will be treated with high level of confidentiality, at the same time, the outcome of this research will be shared in your division.

Hoping for your favorable response on this academic endeavor. Thank you in advance. God bless you.

Sincerely yours,

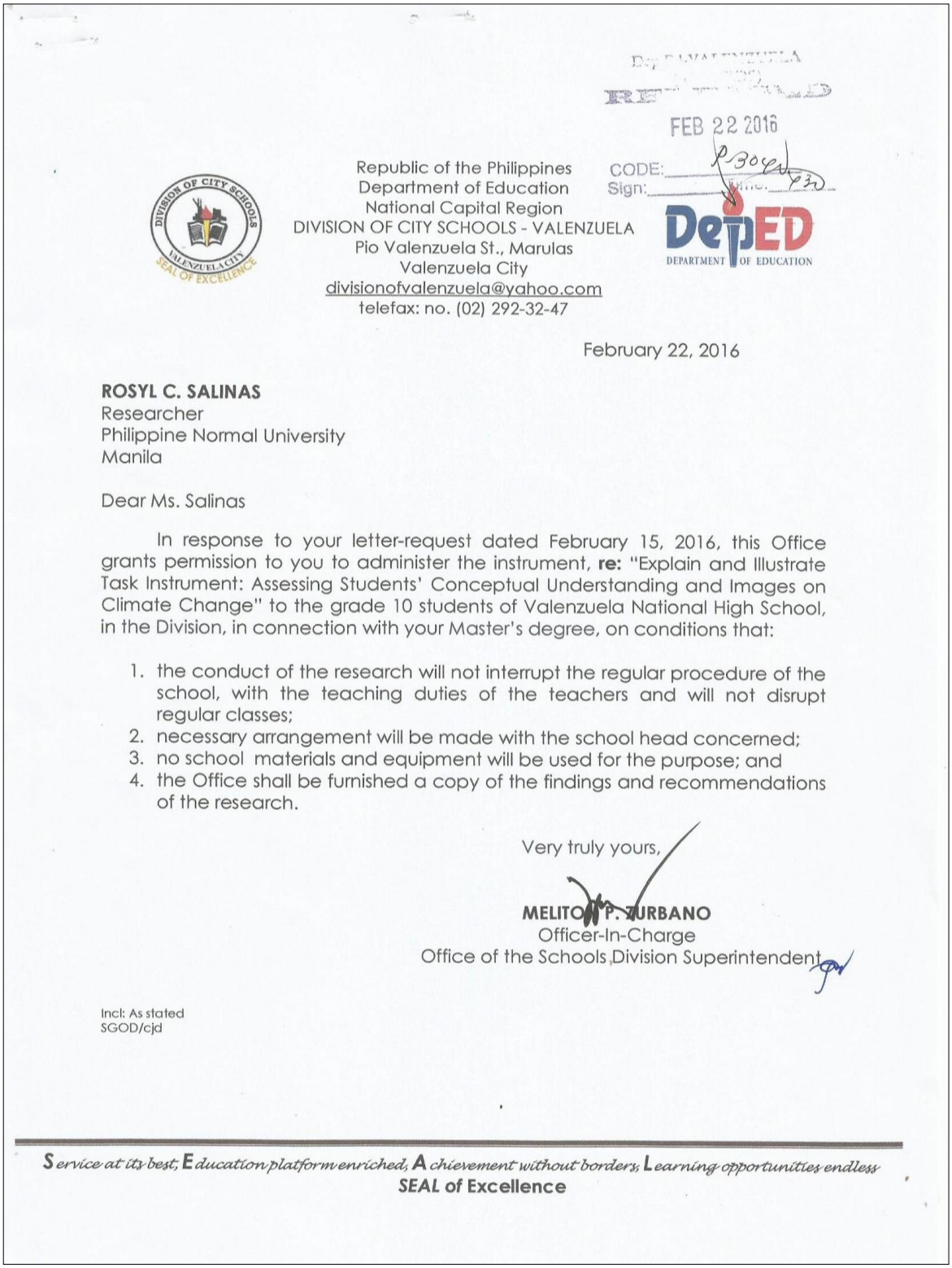
(Sgd) Ms. Rosyl C. Salinas
Researcher

Noted by:

(Sgd) Mr. Brando C. Palomar
Research Adviser

Appendix G2

Communication Letter



FEB 22 2016

CODE: P30

Sign:

Republic of the Philippines
Department of Education
National Capital Region
DIVISION OF CITY SCHOOLS - VALENZUELA
Pio Valenzuela St., Marulas
Valenzuela City
divisionofvalenzuela@yahoo.com
telefax: no. (02) 292-32-47

February 22, 2016

ROSYL C. SALINAS
Researcher
Philippine Normal University
Manila

Dear Ms. Salinas

In response to your letter-request dated February 15, 2016, this Office grants permission to you to administer the instrument, **re:** "Explain and Illustrate Task Instrument: Assessing Students' Conceptual Understanding and Images on Climate Change" to the grade 10 students of Valenzuela National High School, in the Division, in connection with your Master's degree, on conditions that:

1. the conduct of the research will not interrupt the regular procedure of the school, with the teaching duties of the teachers and will not disrupt regular classes;
2. necessary arrangement will be made with the school head concerned;
3. no school materials and equipment will be used for the purpose; and
4. the Office shall be furnished a copy of the findings and recommendations of the research.

Very truly yours,

MELITON P. ZURBANO
Officer-In-Charge
Office of the Schools Division Superintendent

Incl: As stated
SGOD/cjd

Service at its best, Education platform enriched, Achievement without borders, Learning opportunities endless
SEAL of Excellence

Appendix G3

Communication Letter

February 15, 2016

_____
Principal
Valenzuela National High School

Dear _____,

The undersigned is a MASE General Science student of Philippine Normal University and presently conducting a research entitled *"Explain and Illustrate Task Instrument: Assessing Students' Conceptual Understanding and Images on Climate Change"*. The primary purpose of this research undertaking is to probe students' conceptual understanding and images on the different concepts of climate change.

In line with the above-mentioned undertakings, the undersigned would like to request from your good office the approval to allow the administration of the research instrument at Valenzuela National High School. If approval is granted, at least two (2) sections from Grade ten (10) students who will be chosen as the respondents to answer the task instrument on the recommended schedule. The instrument administration will be conducted by the researcher and will be observed for about 45 minutes. Rest assured that responses and data results will be treated with high level of confidentiality, at the same time, the outcome of this research will be shared in your division.

Hoping for your favorable response on this academic endeavor.

Sincerely yours,

(Sgd) Ms. Rosyl C. Salinas
Researcher

Noted by:

(Sgd) Mr. Brando C. Palomar
Research Adviser

MS. ROSYL S. INGCOL

372 C. Rambotan Street Brgy. Culiat Luzon Avenue Quezon City
Contact Number: +639192216796
E-mail Address: rosyl_salinas@yahoo.com/rosylcs@yahoo.com

CAREER OBJECTIVE

To be given an opportunity to further enhance and maximize the potentials in the field of teaching.

TEACHING EXPERIENCE

March 2006 – April 15, 2008
Science Teacher

HIGH SCHOOL TEACHER
Ina ng Buhay Catholic School
Novaliches, Quezon City

- Taught High School Earth Science to first year students including Technology and Livelihood Education and Values from first year to fourth year students
- Devised lessons, which captured the students' imagination
- Managed as the class adviser of first year students.
- Designed and conducted laboratory activities.
- Prepared module and syllabus.
- Tutored two (2) students from grade school.

STUDENT TEACHING EXPERIENCE

HOLY NAME UNIVERSITY – HIGH SCHOOL DEPARTMENT

Janssen Heights Dampas District 6300 Tagbilaran City

- Engaged in teaching Chemistry and Biology subjects in First Year and Third Year Levels.

BIKING HIGH SCHOOL

Biking Dauis Bohol

- Engaged in teaching Biology and General Science subjects in First Year Level.

EDUCATION

Graduate:	**Master of Arts in Science Education Major in** General Science Philippine Normal University, Manila, 2016 Thesis: "Students' Conceptual Understanding and Images on Climate Change
	Bachelor of Science in Education Major in General Science Holy Name University, Tagbilaran, 2004
College:	Janssen Heights Dampas District Tagbilaran City 6300 Thesis: "Students' Perception on the Use of Science Facilities in Relation on their General Science Performance" Graduated being a scholar Eligibility: 2005 LET Passer
	The Sisters of Mary School, Cebu J.P. Rizal Street, Poblacion Talisay Cebu, 2000
Secondary:	Graduated being a scholar
	Dauis Central Elementary School Union, Poblacion, Dauis Bohol, 1996
Primary:	

TRAININGS AND SEMINARS ATTENDED

Leading the Way in ICT – Integrated Education
Stress Management
Interactive Science Devices Demo/Orientation
Personality Development
Classroom Structuring Seminar

PERSONAL DATA

Age: 33 yrs. old
Spouse: Noel E. Ingcol
Children: Adriel Sophia S. Ingcol
Abrielle Shiloh S. Ingcol

This is to certify that the above information is true and correct to the best of my knowledge and beliefs.

_____
Signature