UNIVERSITY OF CAPE COAST

ASSESSMENT OF SENIOR HIGH SCHOOL TEACHERS AND STUDENTS' DEMOGRAPHIC CHARACTERISTICS ON THEIR KNOWLEDGE ON CLIMATE CHANGE IN CAPE COAST METROPOLIS

BY

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Thesis submitted to the Department of Business and Social Sciences Education of the Faculty of Humanities and Social Sciences Education, College of Education Studies, University of Cape Coast, in partial fulfilment of the requirements for the award of Doctor of Philosophy Degree in Curriculum and Teaching

SEPTEMBER 2022

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

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Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

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ABSTRACT

This study assessed senior high school teachers and students' demographic characteristics on their knowledge on climate change in Cape Coast Metropolis. In order to find answers to the research questions and the hypotheses that were formulated to guide the study, the descriptive cross-sectional survey research design was employed. All the 11 public senior high schools participated in the study. The sample size for the students who answered the questionnaires was 371, while the teachers were 289. Both teachers' and students' questionnaires on knowledge on climate change were used to gather the relevant data for the study. The simple random sampling procedure was used to select students and teachers to serve as respondents. The data gathered from the students and teachers were analysed using statistical tools such as means, standard deviations and factorial analysis of variance. It was found out that impartation of climate change knowledge by the senior high school teachers depends on their age and subject taught, while the acquisition of climate change knowledge by the senior high school students depends on their age and programme of study. It was among other things recommended that Unit heads of the various senior high schools should assign experienced teachers to teach climate change knowledge to Business, Visual Arts and Home Economics students. The National Council for Curriculum and Assessment (NACCA) should introduce more topics on climate change into the senior high school Social Studies curriculum.

KEY WORDS

Cape Coast Metropolis

Climate change

Demographic characteristics

Senior high school

Students

Teachers

ACKNOWLEDGEMENTS

While I am wholly responsible for any error and criticism that may arise from this work, I am most grateful to my principal supervisor, Rev. Prof. Kankam Boadu, and co-supervisor, Prof. Peter Kwabenah Acheampong, for their patience and timely responses to my calls, questions, and problems whenever I called on them. Also, my profound gratitude goes to Mr. Emmanuel Otsin, Mr. Isaac Asante, Mr. Samuel Donkor, Mr. Edmund Kwesi Agormedah, Mr. Francis Nyamekye and Miss Lydia Oforiwaa Mensah for their support during the research. Finally, I am highly indebted to the Head teachers, teachers and students of senior high schools in the Cape Coast Metropolis, who spent time and efforts to participate in the study.

DEDICATION

To Rev. Akwasi Asuako of Gethsemane Bible Ministry, Mampong- Ashanti

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CHAPTER ONE

INTRODUCTION

Overview

This chapter presents on the assessment of senior high school teachers and students' demographic characteristics on their knowledge on climate change in Cape Coast Metropolis. This study is very important to the teacher during lesson preparation, selection of teaching-learning resources, methods, and models for effective climate change learning. Several researchers have investigated the knowledge on climate change. The majority of the research works on knowledge on climate change concentrated on tertiary learners, teachers' perception, pre-tertiary students' notion and view of the climate change. As such studies have been done on teachers and students' demographic characteristics on knowledge on climate change outside Ghana, the available literature shows that little has been done in Ghana.

Social reconstructionism theory and the constructivist theory of learning underpin the study. The theoretical implication is that teachers need climate change knowledge before they can impart it to their students, the impartation of climate change knowledge may depend on teachers' demographic characteristics. With the help of students' demographic characteristics, learners will be able to construct their knowledge on climate change. Both senior high school teachers' and students' knowledge on climate change will eventually help reconstruct society through mitigation and adaptation of climate change.

Background to the Study

The Intergovernmental Panel on Climate Change ([IPCC], 2007a) stresses that climate change is real, besides, it has had an influence on the societal and financial development of nations. This assertion has been supported by so many people and organisations (Acheampong, 2016; Chen, 2006; United Nations Educational, Scientific and Cultural Organisation [UNESCO], 2010; United Nations Framework Convention on Climate Change [UNFCCC], 2011; National Research Council [NRC], 2010a; United Nations [UN], 2019). Acheampong (2016) for instance supports this assertion with evidence of the increment of the height of the ocean, great meteorological conditions occurring in places, animals and plants species disappearing, temperatures increasing, and the thawing of ice in the North and South Poles. Therefore there is the need to have complete knowledge about this phenomenon and its impacts.

According to IPCC (2007a), and several other scientists such as Bast (2013), Chen (2006) and Nicole (2012), climate change denotes whichever shift in typical weather within a period, either caused by nature or anthropological action, that may be determined (using statistical data) through fluctuations of means in their variables which is able to withstand a prolonged time, generally ten years or more. A typical instance is mean rainfall and hotness for Cape Coast for 30 years were 279.40mm and 26°C respectively and the next 30-year average values were 200mm and 30°C respectively, then Cape Coast has experienced climate change in the second 30-year period (Acheampong, 2016).

Complete knowledge about climate change and its impacts depend on several factors such as experience, observation, attitudes and, demographic characteristics. Some researchers (Awusi & Asare, 2016; Falaye & Okwilagwe, 2016; McCright, 2010; Suyatna & Rosidin, 2017) believe that a person's knowledge of climate change depends on his or her demographic characteristics. Demographic characteristics of individual according to Salkind (2010) and Investopedia Staff (2019), include age, race, gender, ethnicity, religion, income, education, homeownership, sexual orientation, marital status, family size, health, and disability status, belief, norms, political dispensation, observation, experience, economic/industry, temperament, trust, mental condition, and psychiatric diagnosis. For this thesis, 'demography' is limited to senior high school teachers' characteristics such as gender, age, subject taught, year level taught, and educational background. It is also limited to students' characteristics such as age, gender, student's religion, subject affiliation, parents' educational levels, participation in climate change workshops by students, their affiliation of environment-related student clubs, and their regional manifestation of climate change impacts.

Researchers (Akrofi et al., 2019; Anne, 2016; Awusi & Asare, 2016; Falaye & Okwilagwe, 2016; McCright, 2010; Suyatna & Rosidin, 2017) opine that demographic characteristics that include (age, gender, subject taught, level taught, educational background, sources of information on climate change, students' religion, subject affiliation, parents' educational levels, participation in climate change workshops by students, membership of environment-related student clubs and regional manifestation of climate change impacts) effectively affect people's knowledge on their environment.

Hence, there is a persistent quest to investigate which demographic characteristics determine knowledge on climate change. To this end, Anne (2016) reported that a teacher's age, gender, subject taught and the level taught, influence the climate change knowledge of teachers. Suyatna and Rosidin (2017) have reported that a teacher's teaching background, gender, educational background influence knowledge on climate change.

In addition, certain researchers (Awusi & Asare, 2016; Falaye & Okwilagwe, 2016; McCright, 2010; Suyatna & Rosidin, 2017) claim that the gender of students influences their knowledge on climate change. The authors (Awusi & Asare, 2016; Falaye & Okwilagwe, 2016; McCright, 2010; Suyatna & Rosidin, 2017) specified, learners' gender affects the way learners acquire knowledge on climate change. Other demographic characteristics that have been found to influence students' knowledge on climate change include where learners get their information on climate change (Awusi & Asare, 2016) and the age of the students (Awusi & Asare, 2016; Falaye & Okwilagwe, 2016).

Furthermore, Falaye and Okwilagwe (2016) found out that, student's religion, subject affiliation, and parents' educational levels influence students' knowledge on climate change. Moreover, Akrofi et al. (2019) have indicated that membership in climate change workshops by students, then learners' affiliation to environment-related learner association, impact learners' knowledge on climate change. The authors (Akrofi et al., 2019) also indicated that learners' understanding of climate change, especially in Africa, is influenced by their regional manifestation of climate change impacts. Hence, irrespective of the roles performed by the school in the development of the learner, the learners' surroundings also count. This thesis dwells on the

assessment of demographic characteristics of students and teacher's knowledge on climate change.

Statement of the Problem

Organisations such as All Africa (2013), The World Bank Group (2013), Wikimedia Foundation Inc. (2013) and a scholar, Ofei-Nkansah (2013), have given information on the existed circumstances of ecological disasters in the subtropical region and somewhere else triggered by climate change. Researchers such as Badu-Agyei (2012), Boadi (2013), Kunateh (2013), Müller-Kuckelberg (2012), and a body known as GhanaCentric (2010) have stated that Ghana which belongs to the subtropical region is suffering from the ecological disasters triggered by climate change. Kunateh (2013) has mentioned that climate change has triggered several difficulties in Ghana such as variations in precipitation seasons, the rate at which nuisances and infections affect crop farming and animal rearing has increased, a decrease in farm produce, and damage of lifecycle and assets by inundations and deficiencies. These difficulties completely have had adverse effects on economic activities. These difficulties demand Ghana to be determined in order to fight climate change.

Among efforts made in order to fight climate change is formal education (Bangay & Blum, 2010). Bangay and Blum argue that formal teaching and learning is equally essential as healthiness, and that an enlightened populace is greatly prepared to speculate the dangers triggered by a shifting climate, then the enlightened populace will act accordingly. For Ghana to combat climate change through formal education, it has been

integrated into the Ghanaian schools' curriculum (Boakye, 2015). As such, it is expected that students will be familiar with the phenomenon.

A personal observation as a senior high school teacher is that most students in the Cape Coast Metropolis seem to have little or no knowledge about climate change (The researcher's own experience). Analysis of empirical evidence from the students' exercise books, mid-semester test papers and end of semester examination papers in senior high schools in the Cape Coast Metropolis revealed that students' knowledge on climate change are low. As a result, they do not have the power to lessen the causes of climate change and are unable to adjust to the impacts of climate change in their societies.

Also, analysis of empirical evidence from supervisors' form 'A' in senior high schools in the Cape Coast Metropolis revealed that teachers too have little or no knowledge on climate change. Consequently, the teachers do not deliver climate change issues confidently during instructional time. In some cases, the teachers instruct class representatives to copy notes throughout the period and this does not promote effective teaching and learning of climate change issues.

An informal discussion the researcher had with some of the teachers and students across different public senior high schools in the Cape Coast Metropolis (on the 30th October 2019) confirmed the empirical evidence that teachers and students have little or no knowledge on climate change. As a result, the teachers do not deliver well on climate change issues. The students as well do not have the power to mitigate and adapt to climate change in their communities.

The informal discussion further revealed that the demographic characteristics of both teachers and students controlled their knowledge on climate change. Thus, the researcher orally asked if the demographic characteristics of both teachers and students controlled their knowledge on climate change, the vast number of teachers and students said they did not know. The available literature revealed that most students from Nigeria and United States, for example, know much about it (Adebayo et al., 2013; Ayanlade & Jegede, 2016; Gameda & Akalu, 2015; Henry et al., 2012; Olajide et al., 2011; Oruonye, 2011; Spellman et al., 2003).The findings of research elsewhere, for example, Anne (2016), Falaye and Okwilagwe (2016) and Suyatna and Rosidin (2017) show that the demographic characteristics of the teacher and student make students know about climate change.

A lot of researchers (Acquah, 2011; Adebayo et al., 2013; Berk & Schulman, 1995; Fortner, 2001) have investigated the knowledge on climate change. The majority of the research works on knowledge on climate change concentrated on definite clusters of the populace such as third cycle learners alone (Akrofi et al., 2019; Ayanlade & Jegede, 2016; Gameda & Akalu, 2015; Olajide et al., 2011; Oruonye, 2011; Spellman et al., 2003). Other studies like those by (Anne, 2016; Ekpoh & Ekpoh, 2011; Nkechi & Boakye-Yiadom, 2015; Stephen, Kibett & Obaro, 2014; Whigan, 2014) focused just on teachers and were limited to perception. Other studies (Boyes & Stanistreet, 1997; Henry et al., 2012; Kariuki, 2017; Njoku, 2016; Owolabi, Gyimah & Amponsah, 2012) also targeted at pre-tertiary students and focused on notion and view of climate change.

As such studies have been done on teachers and students' demographic characteristics on knowledge on climate change outside Ghana, the available literature shows that little has been done in Ghana. Even then the works that have been done in Ghana have dwelt on view and notion of knowledge on climate change. The inadequate research in this respect leaves educationalists and stakeholders in teaching and learning with doubt through whatever is occurring concerning teachers' and students' knowledge on climate change. This has devised interrogations such as, "what is the knowledge level of senior high school teachers and students on climate change, and which teachers' and students' demographic characteristics control this knowledge?". The necessity to fill these literature gaps, has led to the investigation of the knowledge of senior high school teachers and students in the Cape Coast Metropolis on climate change.

Purpose of the Study

The purpose of this research was to assess senior high school teachers' and students' demographic characteristics on their climate change knowledge in the Cape Coast Metropolis. The specific objectives were to:

1. assess senior high school teachers' level of knowledge on climate change.
2. assess senior high school students' level of knowledge on climate change.
3. examine the differences that exist in senior high school teacher's knowledge on climatic change based on their demographic characteristics (gender, age, subject taught, year level taught, and educational background).

4. examine the differences that occur in the knowledge of senior high school learners on climatic change based on their demographic characteristics (gender, age, programme affiliation, religion, parents' educational levels, sources of information on climate change, membership of climate change workshops, affiliation of environment-related student association and the regional manifestation of climate change impacts).

Research Questions

Research questions were formulated to direct the study. These are:

1. What knowledge level do senior high school teachers have on climate change?
2. What knowledge level do senior high school students have on climate change?

Hypotheses

Two hypotheses were formulated. These are:

1. H_0: There is no statistically significant difference in the knowledge of senior high school teachers on climate change based on demographic characteristics (gender, age, subject taught, form taught, and educational background).

   H_1: There is a statistically significant difference between knowledge of senior high school teachers on climate change based on demographic characteristics (gender, age, subject taught, form taught, and educational background).

2. H_0: There is no statistically significant difference in the knowledge of senior high school students towards climate change based on

demographic characteristics (gender, age, subject affiliation, religion, parents' educational levels, sources of information on climate change, membership of climate change workshops, affiliation of environment-related student association and the regional manifestation of climate change impacts).

H_1: There is a statistically significant difference in the knowledge of senior high school students towards climate change based on demographic characteristics (gender, age, subject affiliation, religion, parents' educational levels, sources of information on climate change, participation in climate change workshops, membership of environment-related student clubs and the regional manifestation of climate change impacts).

Significance of the Study

The study assessed senior high school teachers and students' knowledge on climate change and how demographic characteristics control their knowledge. This study is very important to the teacher during lesson preparation, selection of teaching-learning resources, methods, and models for effective climate change learning.

The study serves as a guide to policymakers and curriculum planners. It follows therefore that, learners' features impacting and speculating their knowledge on climate change shows that the designers of the school syllabus would at all times ponder on the demographic features of students. This can be done when the Cape Coast Metropolis section of the National Council for Curriculum and Assessment of the Ghana Education Service is preparing the syllabus. Since curriculum collected works promote students to be the central

point in the designing of the syllabus; learners' welfares, wants, as well as demographic features ought to be principal. Finally, the study would contribute to research on senior high school teachers' and students' knowledge on climate change.

Delimitation

The scope of this research was restricted to the Cape Coast Metropolis which has eleven senior high schools. The concentration of this present study was to assess teachers and students' demographic characteristics which influence their knowledge on change climate. This research was delimited to only senior high school teachers and senior high school final year students of public senior high schools in the Cape Coast Metropolis. The senior high school final year learners were carefully chosen because they are the students who have gone through all levels of the senior high school curriculum and who as it was reasoned, had the needed information and boldness to express themselves when responding to the questionnaire items.

Limitations

This research utilised the descriptive cross-sectional survey design which relies on self-report data, where respondents give socially accepted responses (Leedy & Ormrod, 2005). As a result, some participants were willing to give socially accepted responses. Secondly, other participants' willingness to accept the questionnaire distributed to them by the researcher during the data collection period was relatively low. An attempt was, however, made to control reliability. Thus, the researcher explained to them that the purpose of the study is for academic exercise and no one will use their honest responses against them. Again, as a weakness to the use of descriptive cross-sectional

survey design, it was difficult for the respondents to answer questions thoroughly. Finally, there is limited generalisation of the findings of the study.

Organisation of the Study

The thesis consists of five chapters. Chapter One presents the background to the study. It describes the purpose of this study, states the research questions underpinning this study, and the associated hypotheses. The chapter further states the importance of this study and indicates its delimitation as well as limitation of this study. Chapter Two deals with review of related literature. The review of the related literature covered the theoretical/conceptual review of this study. This research similarly has a section for empirical studies. Chapter Three discusses the procedure, which includes the research design, the population, sample and sampling procedure, research instruments, validity and reliability of instruments, data collection procedures, and data processing and analysis. Chapter Four presents the results and discussion of the study, while the final chapter, presents the summary, the conclusions established on the findings, recommendations, and the suggestions for future research.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

Overview

This chapter examines the studies that were relevant to the present work. The evaluation of relevant literature allowed comparison of the current research findings with those of similar studies, to allow for the confirmation or refutation of previous conclusions. The first aspect reviews the literature on theoretical issues relating to knowledge on climate change, conceptual matters concerning the concepts of climate, climate change, causes of climate change, climate change impacts, mitigation of climate change, and adaptation of climate change. Similar studies conducted (empirical review) are discussed in the second section.

Theories Underpinning Climate Change Education

This section describes the theories underpinning climate change education. These theories are the social reconstructionism theory and the constructivist theory of learning. The theories are appropriate to the study, on the "assessment of senior high school teachers and student's demographic characteristics on knowledge on climate change in the Cape Coast Metropolis". The implication is that teachers need climate change knowledge before they can impart it to their students, the impartation of climate change knowledge may depend on teachers' demographic characteristics. With the assistance of students' demographic characteristics, learners will be able to construct their knowledge on climate change. Both senior high school teachers' and students' knowledge on climate change will in the end help reconstruct society through mitigation and adaptation of climate change.

Theoretical framework

Social reconstructionism theory

The leading proponents of the social reconstructionism theory are Lester Frank Ward, George Count, Theodore Brameld, Myles Horton and Harold Rugg. Social reconstructionists view their world from a social perspective. The nature of society as it has been, as it is, and as it should be, determines most of their concepts and assumptions. For example, human experience, education, truth, and knowledge are socially defined. Human experience is believed to be fundamentally shaped by cultural factors; meaning in people's lives it is defined in terms of their relationship to society. Education is viewed as a function of the society that supports it and is defined in the context of a particular culture. Truth and knowledge are defined by cultural assumptions; they are idiosyncratic to each society and testable according to criteria based on social consensus rather than empiricism or logic.

As a result, social reconstructionists believe that there is no good individual apart from conception of the nature of the good society. Man without human society and human culture is not man (Counts, 1932a). They believe that there is also no good education apart from conception of the nature of the good society. Education is not pure and mystical essence that remains unchanged from everlasting to everlasting. They believe that there is no truth or knowledge apart from conception of the nature of the good society; and the good society is not something that is given by nature: it must be fashioned by the hand and brain of man (Counts, 1932b). Important here is the belief in cultural relativity. The good individual, the good education, and truth

and knowledge are defined by a particular culture, and the only thing that gives them either meaning or value is the existence of that culture in a particular time and place.

Since society is considered to be currently undergoing a crisis, it follows that its conception of the good man, the good education, and truth and knowledge are also undergoing a crisis. For stability to return, a vision of a good society must be developed. Conceptions of the good man, the good education, and truth and knowledge will be derived from that vision. As individuals reconstruct themselves based on their vision, they act on society so as to bring into existence new conceptions of the good man, the good education, and truth and knowledge; and from the reconstruction of society in accordance with the vision comes the actualisation of these conceptions.

The social reconstructionism theory has elements. These elements are as follows.

1. Deep social structures
2. The individual in society
3. Society and change
4. Society and crisis
5. Reconstruction and vision
6. The school as an institution of change
7. Education as a social process
8. The historical context of social reconstruction theory
9. Aims
10. The child
11. Teaching

12. Knowledge
13. Evaluation
14. Learning

Deep social structures

Underlying the dynamics of society and schools are deep social structures that shape and determine human behavior. When examining, analysing, and comprehending society, social reconstructionists often connect social phenomena to concepts such as colonial Eurocentric conceptions of knowledge, culture, social class, and values. For example, when dealing with social problems, these educators are frequently concerned about how such things as "inequalities, power, and human suffering are rooted in basic institutional structures" (Giroux, 2005, p. 21). When looking at schools, social reconstructionists frequently focus on hidden aspects of the curriculum that invisibly shape human relationships and behavior. Here their perspective might lead them to, for example, examine "schools . . . as part of the existing social and political fabric that characterises the class-driven dominant society" (McLaren, 2007, p. 18).

The individual in society

Social reconstructionists' concern is primarily the forces at work in society that shape human experience and secondly, the individuals at work who shape society (although both function together). The adherents (Lester Frank Ward, George Count, Theodore Brameld, Myles Horton, and Harold Rugg) of this theory focus on economic, political, social, and educational forces that control the impact on individuals in society of such varied issues as

social class, cultural and linguistic heritage, moral trends, and aesthetic movements.

According to Schiro (2007), causal explanations proceed from the dynamics of society as a whole to the dynamics of social subgroups to the individual. In this context, individuals are viewed as fulfilling their potential in relationship to social groups, in interaction with other individuals, and as part of human communities. This does not mean that man is a creature of social determinism. Man is shaped by society and man can shape society. In fact, individuals must first reconstruct themselves before they can reconstruct society. However, interpretations and intentions are expressed with respect to social groups rather than individuals.

Society and change

The social reconstructionists' view of society is one of historical evolution: societies pass through periods of evolution, stability, and degeneration (Schiro, 2007). One of the prime characteristics of our society is that it is undergoing change that threatens its survival. Whether because of technological, economic, political, cultural, racial, or psychological factors, many of our society's problem solving strategies and institutions are dysfunctional. If society fails to detect that its problem solving strategies and institutions are dysfunctional, these strategies and institutions will become threats to its survival. The situation of society, however, is full of promise as well as menace.

Society and crisis

The proponents of social reconstructionism assume that our society is unhealthy indeed, that its very survival is threatened because the traditional

mechanisms developed by society to contend with social problems are incapable of doing their job. Social reconstructionists believe that the survival of our society is threatened by many problems. These problems include, among others, racism, war, sexism, poverty, pollution, worker exploitation, global warming, crime, political corruption, population explosion, energy shortage, illiteracy, inadequate health care, and unemployment (Schiro, 2007). Again, they assume that something can be done to keep society from destroying itself. This assumption necessitates the development of a vision of a society better than the existing one, a society whose problems have been resolved. It also requires action directed towards reconstruction of society based on that vision. Social reconstruction educators assume that education provides the means of reconstructing society. As Counts (1934) puts it this way:

> Today, as social institutions crumble and society is shaken by deep convulsions that threaten its very existence, many persons are proclaiming that education provides the only true road to safety. They are even saying that it should be brought into the service of building a new social order (p. 533).

Social reconstructionists have faith in the ability of education, through the medium of curriculum, to educate the masses of humanity to critically analyse themselves in relation to their society, understand the ills of their society, develop a vision of a better world based on a conception of social justice, and actualise that vision (Giroux, 2005). According to Giroux (2006), educators need to assume the role of leaders in the struggle for social and

economic justice and educators must connect what they teach and write to the dynamics of public life and concern for democracy.

Reconstruction and vision

Faced with the crises of society, social reconstructionists devise a vision of a new, better society that lacks its existing problems. They then develop educational programs that allow people to see the differences between the crisis-ridden present society and the future good society in such a way that it motivates them to transform the current society into the future one. Social reconstructionists do not accept current societal conditions as permanent principles. Nor do they accept present social conditions as factors to be improved through simple tinkering. They reject certain aspects of the present crisis-ridden society, and they attempt to build a new society out of the existing one rather than attempt to perfect the best aspects of the existing society in hopes that this will make the present society more just and equitable. They seek to provide "for qualitatively better life for all through the construction of a society based on nonexploitative relations and social justice" (McLaren, 2007, p. 195). In assuming that the way to overcome the present social crisis is to envision and implement a future better society, social reconstructionists assume that people need a "compelling and challenging vision of human destiny" (Counts, 1932a, p. 259) that points the way to better social conditions.

The social reconstruction vision of the future good society has several characteristics. First, it is not a finished vision that portrays in precise detail a utopia in its ultimate state, but rather a vision of direction that points to the way society must move toward reconstruction. It is "a vision of the

possibilities which lie ahead" (Counts, 1932b, p. 37) rather than the endpoint that society should reach in order to achieve perfection (Freire, 1993). Second, the vision does not prescribe a specific program of action that dictates how it is to be achieved. The situations in which people find themselves determine this. The vision is a general one that provides values and directions, not a blueprint that specifies exactly how to build the future good society. This is as it should be, given the social reconstruction belief in social relativity and the uniqueness of the particular "time, place, and circumstances" (Counts, 1934, p.1) in which people find themselves.

Third, the vision of the future good society is created in response to existing social conditions. As such, it embodies both a picture of reality as it is and a vision of reality as it ought to be. Its power lies in its ability both to offer people salvation from an intolerable reality, reality as it is, and to offer them a vision of life as it should be. Understanding the vision requires that one understand society as it is in order to fully appreciate society as it ought to be. Fourth, the social reconstruction vision is a social rather than individual vision. It is a "public vision of self- and social empowerment," a "vision . . . that extend[s] the principles of liberty, equality, justice, and freedom to the widest possible set of institutional and lived relations" (Giroux, 2005, p. 74). It is a vision that allows the masses, which comprise society, to overcome their problems together and to collectively achieve the good life. It is not a vision that allows certain individuals to achieve the good life and escape from their problems at the expense of others. The social reconstruction vision of the future good society helps people reconstruct society in several ways.

1. The vision allows people from diverse situations to rise above their particular circumstances to see social crises as a whole (as, for example, when African Americans, Mexican Americans, and Native Americans see that they are all oppressed), allows them to share a common vision of a better life, and allows them to act together to meet common needs and to collectively better themselves and improve society as a whole (Apple, 1996).
2. The vision offers people an alternative to and the possibility of escape from their crisis ridden society through "a language of possibility . . . [that] goes beyond critique," "a positive language of human empowerment" (Giroux, 1992, p. 10). Without the perception that their oppression can be overcome and without a language that allows them to speak about overcoming their oppression, people would not be able to wage the struggle to reconstruct their society.
3. The vision has inherent values that enable people to see their problems as solvable rather than to simply accept them as innate characteristics of their world. For example, someone who places no value on freedom would not see the lack of it as a problem. Educating people to value freedom prepares the way for dissatisfaction that can lead to action. The vision educates people to see problems and to see them as solvable.
4. The vision offers people the hope of something better, hope that can motivate them to act in ways not normal for them. As Freire (1997, p. 45) says, "without a vision for tomorrow, hope is impossible" and any "attempt to do without hope, in the struggle to improve the world, as if

that struggle could be reduced to calculated acts alone, or a purely scientific approach, is a frivolous illusion" (Freire, 1993, p. 2). Giving people hope and courage that allow them to step outside their normal social roles is crucial in motivating them to overcome their social problems, problems that so frequently trap them in hopelessness and ignorance (Greene, 1988).

5. The vision gives people clear long-range goals that offer direction to their thinking so that they do not become distracted from their reconstruction endeavors by the immediacies of daily life. Short-range and vaguely defined goals will not suffice, for "it is now imperative that we know where we want to go . . . because, so long as we do not know we shall be unprepared to go there" (Brameld, 1956, p. 76).
6. The vision of the future good society defines the nature of the good individual, the good education, and worthwhile truth and knowledge. Without the ability to identify these, people would not be able to cultivate them and make them multiply in ways that help reconstruct society.

The emphasis on developing a vision of a good society leads social reconstructionists to utopianism. Here, the distinction must be made between utopias of escape and utopias of social reconstruction. The first leaves society the way it is as small groups or individuals escape from it; the second seeks to change society so that people can live in it and interact with it on their own terms (Mumford, 1933). Social reconstruction visions are utopias of social reconstruction.

The school as the institution of change

Social reconstructionists dedicate themselves to the reconstruction of society. Their approach consists of analysing and understanding society, constructing a vision of an improved society, and acting to transform the existing society into a better one. This approach is embedded in school curricula that are taught to students. Schools then become the social institution through which leadership is provided and action is initiated to reconstruct society. Education, thus, has the role of preparing people to transform society. By doing so, they will reconstruct society. This requires educators to assume new roles and functions, for at present they are meek followers of social consensus rather than dynamic leaders who mold social beliefs and values.

This means that instead of shunning power, the profession [of education] should rather seek power and then strive to use that power fully and wisely and in the interests of the great masses of the people (Counts, 1932b), for if the schools are to be really effective, they must become centers for the building, and not merely for the contemplation of our civilisation. Schools must face squarely and courageously every social issue, come to grips with life in all of its stark reality, establish an organic in relation with the community, develop a realistic and comprehensive theory of welfare, fashion a compelling and challenging vision of human destiny, and become somewhat less frightened than they are today of the bogeys of imposition and indoctrination (Counts, 1932a).

For this to be accomplished, current conceptions of education (which view schools as transmitters of established disciplinary knowledge and social values) must be reconceptualised so that they are in phase with a vision of the

future based in concepts of social justice and human empowerment and so that they prepare students to live in and to transform our current society into the envisioned future society. Schools will then be catalysts that stimulate the reconstruction of society.

Education as a social process

Schiro (2007) indicates that social reconstructionists want is to reconstruct society through social processes. Their first concern is the education of the group and their second, the education of the individual. From this perspective, learning experiences are construed to be group experiences that take place through human interaction, and the focus is on the group mind rather than the individual mind. Individuals are critical to the ideology, for it is through the reconstruction of individuals that one reconstructs society. However, the education of individuals is viewed as achievable primarily through group-centered, social processes.

Here, one speaks of social self-realisation for both the society and individuals, not of individual self-realisation. Here social consensus plays a central role, for it is believed that once social consensus is reached about the nature of current society and the vision for the future society, it will be possible for the masses to reconstruct society. The aim is to fashion, through education, a social consensus among the masses that will by majority rule force society to align itself with the vision of the future good society and eradicate current social ills (Schiro, 2007). It is through the creation of social consensus that educators hope to achieve social reconstruction both by and for society.

The historical context of social reconstructionism theory

One could say that the origins of the social reconstruction ideology in the U.S. are as old as the founding of the nation. Cremin (1977) claims that the American Revolution was essentially a matter of popular education and that teachers used the lectern to nurture ideas of independency, while students organised symbolic actions ranging from burning in effigy to boycotts of tea as much of the population of the countryside opposed British political, economic, and social practices. Lester Frank Ward began the discussion of the social reconstruction agenda in the 1880s and 1890s with the publication of 'Dynamic Sociology' in 1883, and 'The Psychic Factors of Civilisation' in 1893. He asserted that men had the ability to influence the social world in which they lived through their application of intelligence to the problems of their society and suggested that education through the development of intelligence could influence society to be a more just and equitable place for people.

John Dewey prepared the way for the social reconstruction ideology in 'Reconstruction in Philosophy' in 1948, where he described education as a crucial ingredient in social and moral development, and in 'Democracy and Education' in 1916, where he described education as "that reconstruction or reorganisation of experience which adds to the meaning of experience, and which increases ability to direct the course of subsequent experience" (p.76). The ideology was formally brought to life for educators in 1932 when George Counts gave a rousing presentation at the Progressive Education Association annual meeting in which he asked, "Dare the school build a new social order?" This speech led to a deep split in the Progressive Education

Association between those who advocated the social reconstruction ideology and proponents of the learner centered ideology (Schiro, 2007). The social reconstruction ideology flourished during the Great Depression of the 1930s, during which many educators questioned the American way of life. Myles Horton started Highlander in 1932 to help labor deal with the oppression of industry.

A bit later, Harold Rugg published a popular social studies textbook series in which he introduced students to controversial economic, social, and political issues in 1936 and in 1937. World War II dimmed the flame of the ideology, but during the 1950s Theodore Brameld wrote books such as 'Toward a Reconstructed Philosophy of Education' in 1956 advocating the social reconstruction ideology. During the 1960s and 1970s, the civil rights movement, the women's movement, and the protest against the Vietnam War were stimulated and supported by adherents of the social reconstruction ideology. Neil Postman and Charles Weingartner wrote 'Teaching as a Subversive Activity' in 1969 and other such books to promote the ideology. In the last quarter of the 20th century and the first years of the 21st century, critical theory began to flourish in academia in a variety of highly competitive forms, including postmodernism, post structuralism, radical feminism, and critical constructivism (McLaren, 2007).

These forms of critical theory revolted against traditional ways of viewing and conceptualising our world; against powerful (oppressive, exploitative, and/or dominant) social groups who made economic, cultural, and educational decisions affecting the lives of those less powerful; and against rationalist, Eurocentric cultural traditions that privileged those who

were white, educated, rich, and male in comparison to those who were nonwhite, uneducated, poor, or female. They focused on the subjective and social construction of knowledge rather than on objective knowledge (Schiro, 2007). Critical theory is concerned with emancipation through the questioning of political, economic, social, and psychological conventions that have been previously taken for granted. It is critical of these conventions, using a value system based on social justice and equity, and it promotes action to improve society and the individual through education. Advocates of critical theory sought to do research like that of Jean Anyon in 1980, who demonstrated how the hidden curriculum of education influenced the work expectations, aspirations, and perspectives of children of different economic classes.

Advocates of critical pedagogy also sought to engage in practical educational endeavors like those of Brazilian educator Paulo Freire, who in 'Pedagogy of the Oppressed' in 1970 described how poor people with little political, economic, or social power could take control of their lives and education by critically examining the social, political, economic, and psychological forces that enslaved them. Advocates of critical pedagogy sought to write social analyses like those by Michael Apple, who in 'Ideology and Curriculum' in 2004 and 'Education and Power' in 1995 described how schools are reproductive agents of society that maintain social power relationships by socialising students to society's conception of appropriate class, gender, race, political, cultural, and economic relationships among people through the hidden curriculum of the school. During the last decade of the 20th century and the first years of the 21st century, aspects of the social reconstruction ideology have become fashionable among university faculty in

departments of education. Some of the slogans they frequently use include 'social [cultural, economic, and political] justice', 'empowerment', 'critical analysis', and 'praxis' (Schiro, 2007). Social reconstructionists' aims, views of children, teaching, knowledge, evaluation and learning are as follows.

Aims of social reconstructionism

Schiro (2007) is of the view that the aim of social reconstructionists is to eliminate from their culture those aspects they believe undesirable, to substitute in their place social practices and values they believe more desirable, and in so doing to reconstruct their culture so that its members attain maximum satisfaction of their material, social, cultural, and spiritual needs. They wish to redirect the growth of their society to reconstruct it into a more just, satisfying, democratic, egalitarian, and humane society than the current one. To accomplish this, social reconstructionists attempt to create a social consensus that rejects the faults of the existing society and affirms the virtues of a future good society. To develop the social consensus. educators manipulate society at the point where it inducts children into the life of the culture: society's educational system.

Their intent is to educate youth to reconstruct our current society and to live in a society superior to the existing one (Schiro, 2007). To do this, they build a social, political, economic, and cultural educational program that is a curriculum. This is where different visions of the future good society and different strategies that suggest how to transform today's society into the future good society exist. The overall social reconstruction orientation, however, begins with analysis of society, moves to the creation of a vision of a subjective future good society, and then moves back to manipulation of the

existing social reality to transform it into the future good society that will provide its members with the maximum possible social, cultural, economic, and political equality, satisfaction, and justice. In the process, as new social problems and crises arise, members of society become empowered to continually reconstruct themselves and society.

The child in social reconstructionism

Children are not viewed primarily as children rather they are viewed as products of society, as social actors, and as potential contributing members of society who can aid in its reconstruction (McLaren, 2007). As Giroux (1992) indicates, "social betterment must be the necessary consequence of individual flourishing" (p. 11). Children carry within themselves unique collections of individual meanings that result from experiences they encounter. They bring to school not only their potential to act in the future but also their past histories from family, peer group, and community interactions as well as their personal meanings and ways of thinking that result from such interactions.

At birth, a child is by nature neither good nor bad; he is merely a bundle of potentialities which may be developed in manifold directions (Counts, 1932b). Throughout their lives, children are "unfinished, uncompleted beings" (Freire, 1970, p. 72) in the process of "becoming [ever] more fully human" (p. 52). It is the role of education to guide the development of the child's potentialities so that they contribute to the functioning of the good society, which will in turn give value to the developed potentialities. Children are "born helpless" (Counts, 1932b, p. 13). As they grow, they develop the power and freedom to mold their world. It is the role of education

to guide the development of children's growth so that they use their freedom and power to mold today's society into the best possible future one.

At birth, children are viewed as meaning-making organisms that contain little meaning. As they grow, children construct meaning by actively interpreting the world to themselves. It is the role of education to shape the meaning created by children and the ways in which children make meaning so that they can act to support appropriate visions of a future good society. Children are not viewed primarily from a developmental context that emphasises their living fully in each stage through which they pass. As they grow, children progress toward an educated state from which they can contribute to society's reconstruction. It is the role of education to speed children toward this educated state.

Children are viewed as meaning makers because they make meaning for themselves as the result of being stimulated by the environment in which they live. According to Schiro (2007), there are several corollaries to the assumption that people are meaning makers:

a. Subjective reality within learners is distinguished from objective reality outside of learners.
b. Meaning is assumed to reside in individuals' subjective realities and not outside of individuals in objective reality.
c. Children are believed to make meaning as a result of being stimulated by their environment (which includes teachers, other children, the community, and any other experiences they might encounter in their world).

d. It is assumed that children actively make meaning for themselves; they are not passive absorbers of meaning conveyed by agents external to themselves.

In viewing children as meaning makers, four aspects of children's minds are distinguished (Schiro, 2007). These are:

i. Children's minds have contents, called meanings that include such things as their knowledge, beliefs, facts, theories, affiliations, fears, and hopes.

ii. The contents of children's minds are stored in a meaning structure that contains, among other things, the organisation of meaning in children's minds and the functions governing the intake, output, and redistribution of their meanings.

iii. Children have perceptual filters and functions that control the types of stimuli they perceive from the many sensations that impinge on them. These filters and functions control the manner in which children perceive reality.

iv. Children's minds have interpretive functions that control how they give meaning to the sensations they perceive and thus how they interpret reality.

According to Schiro (2007), children's perceptive functions, interpretive functions, and meaning structures are important to social reconstructionists because they affect the manner in which children perceive, interpret, and organise reality. They affect, for example, whether or not children hear certain overtones in peoples' complaints about society, how they interpret the overtones they hear, and how they give meaning to that information by fitting

it into their meaning structure. While creating or teaching curricula, educators design and use instructional strategies to influence these structures and functions as well as children's meanings.

Children in society are viewed primarily as members of a social group, not as individuals. They realise their potential in social interaction with others, are educated in a social community, and act as part of a social group to bring into existence the future good society. Two types of communities to which children belong are of interest to social reconstructionists: the community outside the school, in which children spend most of their life and on which they must act to reconstruct society; and the community in the school, over which the educator exercises control (Schiro, 2007).

According to Schiro (2007), Social reconstructionists have the task of figuring out how to both (1) bring aspects of society that function outside the school into the school so that they can be used to educate children while they are in school, and (2) bring endeavors that take place during school time outside the school so that children can have firsthand experiences in their community. Bringing children's lives from outside the school into school involves dealing with all aspects of their lives, including their experiences, thoughts, feelings, dreams, and ways of relating, valuing, and acting, which are relevant both inside and outside the school.

Teaching in social reconstructionism

At one level, the intent of teaching is to reconstruct society. At another level the intent of teaching is to stimulate students to reconstruct themselves so that they can contribute to the reconstruction of society. At still another level, the intent of teaching is to stimulate students to learn how to reconstruct

society. Stimulating students to learn how to reconstruct society involves helping them construct a set of meanings, meaning structures, perceptive functions, and interpretive functions so that when they encounter social problems they can analyse and understand them, formulate a vision of better society where those problems do not exist, and act in such a way as to eliminate those social problems (Schiro, 2007). It is important to note that it is not just students' meanings that social reconstructionists want to have an impact on. They want to stimulate students to construct a method of perceiving and interpreting social events, developing a social vision, and acting that will allow them to confront as yet unknown future social crises. Providing students with a method is critical.

Given the social reconstruction belief in social relativity, it is important that students be taught an approach to confronting social problems rather than a fixed formula that has proved useful in confronting past or present social problems (Schiro, 2007). Society's past and present condition is not the only consideration, here at stake is society's future. Social reconstructionists use a variety of instructional methods. The two discussed here are the discussion and experience methods. Both depend on having students learn indirectly through the media they encounter while engaging in educational activities.

The discussion method, specifically, group discussion is a social means of educating a group of persons. It requires both a social context and social interactions. It is considered an ideal educational medium because it uses language to help groups and individuals construct and reconstruct their knowledge of themselves, their knowledge of society and its strengths and

weaknesses, a vision of a future good society, and a strategy for transforming the current society into the future good society. Here, language is viewed broadly as a primary mediator of human perception, learning, knowing, feeling, and acting. The discussion method of teaching involves engaging a group of students in a conversation while the teacher elicits "from students the meanings that they have already stored up so that they may subject those meanings to a testing and verifying, reordering and reclassifying, modifying and extending process" (Postman & Weingartner, 1969, p. 62).

According to Schiro (2007), the assumption underlying this mode of teaching is that for students to reconstruct their already established knowledge and ways of knowing, they must regurgitate them so that they can be examined and reconstructed during the discussion process. Group discussion accomplishes this transformation and reconstruction of knowledge by getting participants to disclose to the group their social understanding so that the group can help them reconstruct their social knowledge in light of the knowledge of the group as a whole. Knowledge can thus be reaffirmed and elaborated by the group to give greater insight into it; shown to be inaccurate or incorrect, so that it can be made accurate or correct by the group's pointing out of its errors; shown to be inadequate because it lacks connection to appropriate social values, so that it can be made more adequate through group processes; or shown to be deficient because it lacks the necessary commitment and inspiration, so that the group can help develop such in the participant.

The process involves getting participants to expose their knowledge to the group so that the group can comment on that knowledge in such a way as to allow participants to reconstruct their knowledge in light of the group's

comments and peer pressure, all under the careful guidance of teachers who differentially reinforce group understandings and values to guide the group to acquire understandings and values consistent with those of the teacher (Schiro, 2007). The content for a discussion comes from those involved in the discussion. It is a re-presentation to the group by its members of things they have experienced or already understood and now want to understand more or in a new way. Thus, the actual social experiences and knowledge of those involved in the dialogue are crucial.

In view of Schiro (2007), discussion is defined by those experiences and that knowledge must take into account those experiences and that knowledge as the persons who have had them perceive them. Although the discussion is defined by the perceived experiences and knowledge of its participants, it is not limited by those experiences and that knowledge, because the social interactions that take place during a discussion can expand on the experiences of its participants (as when two people's thoughts are joined together to generate a new thought neither would have been capable of generating alone) and because the group can re-present the experiences of participants back to them so that they can see them in a new way and thus perceive, experience, or construct them anew (as when a person's interpretation of the meaning of a particular experience allows another person who has had a similar experience to understand that experience in a new way).

Social reconstructionists believe that a discussion (and a person's education) must start where the participants are; must start with what people have experienced and what they understand, as they themselves perceive them; and must relate to their prior experiences and knowledge (McLaren,

2007). As a result, social reconstructionists must either find a way to tap into the prior experiences and knowledge of those who will experience a curriculum or find a way to provide them with the experiences and knowledge the curriculum will build on. Important here is the centrality of the social experiences and knowledge of those participating in the discussion. Anything said during the discussion as well as any input into the discussion from sources such as outside experts, books, movies, or the like must relate to the prior experiences and knowledge of participants if they are to benefit from them.

At their best, group discussions have three crucial components: thought, commitment, and action (Schiro, 2007). The potential for all three must be present in a group discussion for it to be vital. If a group discussion lacks the potential for action, then the thinking that takes place during it degenerates into useless verbalism. If a group discussion lacks the potential for thought, then the action that takes place as a result of it degenerates into meaningless activism (Freire, 1970). If a group discussion lacks the potential for commitment, then the thinking that takes place during it will lack the power to be transformed into action. If a group discussion does not carry the potential for thought about society as it is and as it ought to be, the potential for commitment to transforming current society as it is into society as it ought to be, and the potential for action directed toward such, then the discussion is not vital within the context of the social reconstruction ideology.

According to Schiro (2007), social reconstruction group discussions take place at two levels: (1) an explicit level at which students are openly challenged by analysis of the present social crisis and vision of the future

good society, and (2) a hidden level at which students are subconsciously conditioned by group norms to have a particular social perspective and set of social values. At the explicit level of discussion, students are aware of the messages being communicated to them and they consciously and with understanding construct their concepts and conceptual structures. At this level, they are aware of their decisions and choices and what is happening to them while they are being educated. At the hidden level, educators manipulate the hidden curriculum to subconsciously condition students to a way of viewing, valuing, and judging what they experience by subtly socialising them to the educators' perspectives on the world.

At this level, the rules and norms of the group discussion educate members without their understanding what is occurring. When operating at the explicit level, discussion tends to proceed by having students learn about society, verbally analyse society, explicitly formulate a vision of a future society, develop a social conscience that impels them to commit themselves to transform the existing society into the future better society, and decide how to act to implement the future good society. At this level, instruction depends on the power of ideas to move students to reconstruct themselves and society. The belief is that if people think about and understand the reasons for a reconstructed society, they will act in such a manner as to bring it into existence. When operating at the hidden level, the discussion process and the social environment in which the discussion takes place mold students to think and act in accordance with an educator's beliefs.

During discussions, teachers provide the rules for discussion, the desired social perspective and values, and the model for the modes of thinking

in which students are to engage (Schiro, 2007). The instructive function is embedded in the language, questions, evidence, value judgments, modes of argumentation, and criteria of relevance the teacher uses during discussion and urges students to use by example. Thus, if sharing (as compared to competing) is valued, sharing (and the belief that sharing is good) will be directly conditioned into students during the discussion by them being required to conform to discussion norms that demand sharing behavior and censor competitive behavior. Similarly, if critical analysis of social forces is valued, critical analysis will be demonstrated by teachers, students' engagement in critical analysis will be rewarded by teachers, and students will learn critical analysis by conforming to discussion norms that value and reward critical analysis. In these cases, the norms of the discussion and the behaviors expected during the discussion become forces that mold students. Here, it is the medium (the discussion itself) more than the message (the topic of discussion) that is designed to provide the teaching.

To Schiro (2007), the experience method to the social reconstructionists, is from one's experiences with (and knowledge of) an existing social crisis and in response to a perceived difficulty that one has experienced within that social crisis that one is motivated to understand the nature of society, envision a better society, and act to reconstruct society. This means that one's experiences (and related knowledge) play a crucial role in the social reconstruction ideology. It also means that if social reconstructionists want group participants to acquire a particular understanding of a social crisis and they have not already experienced that

crisis, then they must provide for those participants appropriate experiences that will result in the corresponding appropriate understandings.

Important here is that students obtain more than knowledge from a social experience. They also acquire feelings (including feelings about such things as their self-concept and their power to act and make a difference in their world), a social perspective, and a set of values about what is socially just or unjust, good or bad, fair or unfair, right or wrong. The experience method involves placing students in an environment where they encounter a social crisis and learn from those who usually function in that environment. Experiences that students might participate in include public protests, recycling, visiting the elderly in nursing homes, rehabilitating public places in depressed urban or rural areas, and working with battered women, the homeless, or the poor in shelters. The environments in which students are placed and those with whom they work are specially chosen to educate students about particular social problems.

It is assumed that students will absorb the attitudes and values, modes of perception and interpretation, and worldview of those normally engaged in the environment (McLaren, 2007). This is because they will experience firsthand, the reasons for these perspectives and because they will get carried away by the immediacy of the experience in such a manner that they will reconstruct themselves to be like the people who normally function in the environment. Here, teaching involves the provision of firsthand experience with social crises; counseling sessions designed to help students adjust to the environment in which they find themselves; and discussion sessions intended to help them construct meaning from their experiences. Counseling and

discussion sessions are a crucial part of the experience method, for in these sessions students are debriefed and reconstruct their previously held beliefs.

The teacher as a colleague

According to Schiro (2007), social reconstructionists view the teacher as a colleague or companion whom students can look up to rather than as an authority who has control over them. The teacher and the students are considered to be on the same side of both the discussion and the experience. They are allied against the evils of the world. They complement each other rather than combat each other. They teach and learn from each other. The teacher is not viewed as knowing everything and the students as knowing nothing; rather, both bring experiences to share with each other during instruction. It is not that the teacher actively thinks and the students passively absorb; rather, both actively engage in meaning making in the presence of each other.

It is not that the teacher talks and the students listen; rather, both talk and listen as partners in a mutual endeavor. It is not that the teacher chooses content and the students accept it; rather, both have experiences that contribute to the content of instruction. It is not that only students reveal their inner meanings to the group for analysis; rather, both students and teachers contribute their inner meanings to the group for scrutiny for both their own and the group's educational benefit. It is not that teachers teach and the students learn; rather, both teach each other and learn from each other. It is not that teachers are emotionally disengaged and detached from discussions and experiences; rather, both teachers and students become emotionally engaged

in learning and present to each other their thoughts and values, and these responses are considered interconnected.

Characteristics of teaching

According to Schiro (2007) and McLaren (2007), several characteristics of what social reconstructionists consider good teaching are common to both the discussion and experience methods.

a. Both are group methods and make use of group pressures to teach students. Not only are the messages often social, but also the medium used to convey the messages is a social medium.

b. Both methods depend on the relevance of their message in students' lives. In the experience method, relevance comes from the immediacy of the situation in which students find themselves. In the discussion method, topics often come from the expressed concerns of students.

c. In both methods, teachers find out what students know, draw it out of them, and help them reflect, analyse, and reconstruct their meanings in a value-laden context where values shape much of what and how students learn.

d. The important messages in both methods are often subliminal ones conveyed through the learning medium such as the rules of proper discussion or the proper values (for instance, social justice) with which to view and interpret experiences.

Characteristics of teachers

Three characteristics of teachers deserve mention. Social reconstructionists view the attitudes, interpretations, and visions of teachers to be of crucial importance. There can be no significant innovation in education

that does not have at its center the attitude of teachers. The beliefs, feelings, and assumptions of teachers are the air of a learning environment; they determine the quality of life within it (Postman & Weingartner, 1969). Teachers must be capable of reflecting on themselves and on their society and of using critical analysis to raise fundamental questions about the social, economic, and political forces shaping their lives and the lives of their students so that they can all be better prepared for participating in and changing the larger world (McLaren, 2007).

That is, they must be able to critically analyse the ideologies, values, and interests that inform their role as teachers and the cultural politics they promote in the classroom. Giroux (2006) is of the view that teachers should be able to analyse their relationship with the larger society in order to critically apprehend themselves as social agents capable of recognising how they might be complicitous with forms of oppression and human suffering; able to analyse the deep cultural, social, political, and economic forces that contribute to injustice and inequality in their society; and able to envision a future better society and act to bring it into existence. Social reconstructionists believe that teachers should be qualified to provide vigorous, enlightened, and public-spirited leadership, ready and competent to challenge the power of selfish interests and to champion the cause of the masses of the people.

Knowledge in social reconstructionism

Social reconstructionists view worthwhile knowledge to be a social construction. Here, knowledge (truth) is socially constructed, culturally mediated, and historically situated and dominant social discourses determine what counts as true, important, and relevant (McLaren, 2007). In addition,

worthwhile knowledge is viewed as being constructed out of social interactions for social, political, economic, or cultural purposes. Knowledge and value knowledge is a value-laden social construction (Joseph et al., 2000). It embodies both truth and value. It embraces both intelligence and a corresponding moral stance with respect to that intelligence (whether in the form of meaning, functions, or structures). Knowledge and values are interconnected. This interconnection has its origin in social reconstructionists' view of reality from the perspective of current social crisis and a future good society.

By processing reality through a vision of a future good society, intelligence becomes good or bad, worthwhile or worthless, moral or immoral, ethical or unethical (Giroux, 2005), emancipatory or oppressive (McLaren, 2007) as it supports or refutes an educator's utopian vision. Values and intelligence are considered real in the same way, and little differentiation is made between the questions "Is x real?" and "Is x moral?". A scientific fact (political interpretation, religious hope, or affiliative emotion) is judged by the question, "Is it worthwhile intelligence with respect to the analysis of the existing society and projection of the future society?". Knowledge is not an impartial quantity and knowing is not a neutral affair. Knowledge is of worth because it contributes to the attainment of a future good society, and the construction of knowledge is a moral activity inseparable from the cultural activity of searching for and implementing a satisfactory vision for the future good society.

Social reconstructionists distinguish between subjective reality and objective reality. They believe that worthwhile knowledge resides within the

subjective reality of both individuals and society. For them, there is no such thing as subject matter in the abstract. Subject matter exists in the minds of perceivers. What each one thinks it is, is what it is. People have been acting in schools as if knowledge lies outside the learner that is why people have the kinds of curricula they have. But knowledge is what people know after they have learned. It is an outcome of perception and is as unique and subjective as any other perception (Postman & Weingartner, 1969).

Worthwhile knowledge does not reside outside of people in such things as books or magazines (Schiro, 2007). It does not reside in words separate from people. It resides in the meanings people create for themselves. Knowledge is defined in terms of the subjective meaning it has to its possessors. For social reconstructionists, what society and people believe to be true and valuable is more important than what might be true or valuable in any absolute sense. Knowledge resides in its possessor, originates in that possessor's environmental interactions, and is what each person interprets knowledge to be within the context of a relativistic social consensus. This is a crucial assumption. Knowledge's truth and worth are verifiable through social consensus. What the majority of the members of a society believe to be true is true for those persons.

According to Schiro (2007), knowledge is relativistic in nature, and its truth and value depend upon the society within which it exists. For social reconstructionists, there is no such thing as absolute knowledge that is true for all people under all circumstances in all cultures. This does not mean that certain knowledge are not better for certain purposes and certain people than other knowledge. That knowledge which supports educators' analysis of our

past and current society and vision of the future good society is the knowledge of most worth to them. It is that knowledge which educators desire their society to accept and acquire through social consensus.

The acquisition of knowledge

In discussing the creation of knowledge, two cases need to be distinguished: the creation of knowledge by members of society and the creation of curriculum knowledge (Schiro, 2007). Members of society create the knowledge they possess. Knowledge does not come into existence by itself and passively reside in objective reality. It comes into existence when someone actively impresses meaning on sensory data, and it resides within the subjective consciousness of its possessor. The process by which a person actively loads meaning and value onto sensory data is the process by which knowledge is created. Sensory data or objective information without meaning and value loaded onto it by a person is not called knowledge. As such, the meaning structure, the perceptive functions, and the interpretive functions of a person are crucial to social reconstructionists. They are the operators that give meaning and value to the knowledge a person creates. In many ways, it is these meaning-giving operators that educators wish to orient toward their future good society. In so doing, educators bring the knower to share their vision of the future rather than simply cause him or her to be informed about that vision.

In the view of Schiro (2007), the knowledge curriculum developers embed in their curricula has its origin in their subjective interpretation of the nature of society in the past, present, and future. It derives from educators' personal analysis of their world. It is chosen for inclusion in curriculum

because it acts to convert the child into a participant in the developers' visions of the future good society. It is embedded in curriculum with the intention of aligning children's knowledge and ways of knowing with those of developers and of activating children to reconstruct society.

Note here that curriculum knowledge has its origin in educators' subjective view of society and that it is specifically directed toward affecting the subjective consciousness of children so as to make them into change agents who swell the social consensus that will in turn hopefully align society with educators' visions (Schiro, 2007). Objective information, such as that possessed by the academic disciplines, is of little use to these educators, except as value can be loaded onto it so that it supports their vision of the future good society. Academic skills are also of little use except as they can be used as analytical tools for the purpose of reconstructing the knowledge base of individuals and their societies. This leads some reconstructionists to even believe that the enlightenment notion of reason needs to be reformulated because it denies its own historical construction and ideological principals (Giroux, 2005).

Characteristics of knowledge

Six other attributes of knowledge must be mentioned (Giroux, 2006) at this juncture. These are:

1. Knowledge is not viewed as a purely intellectual quantity. Both people's 'gut' knowledge and their 'intellectual' knowledge are important and interdependent. Both their 'unrational' (subconscious) and their 'rational' (conscious) knowledge are valued.

2. Knowledge is both cognitive and experiential in nature. Knowledge is not just 'information about' but also 'experience with' a subject. Knowledge is based both in people's experiences and in their ability to understand those experiences.
3. Although knowledge is a personal attribute of the perceiver, social reconstructionists are concerned with the knowledge possessed by society. Educators wish to reconstruct society by reconstructing the social consensus of the masses thus the summative total of the knowledge held by the many individuals who make up society.
4. Social reconstructionists take a gestalt approach to knowledge, viewing it in relation to other knowledge. Knowledge has meaning and value because it fits into a structure or pattern. Individual bits of information, atomistically unrelated to any organising theme or vision, have little value.
5. Social reconstructionism views knowledge as interdisciplinary in nature and questions the fundamental categories of all disciplines (Giroux, 1992). It creates new forms of knowledge through its emphasis on breaking down disciplinary boundaries and creating new spheres in which knowledge can be produced (Giroux, 2005). This implies that social reconstructionists do not see knowledge in their separate entities or in its watertight compartment rather they see knowledge as a whole. That is to say that they draw knowledge from different disciplines in order to describe a phenomenon, explain an issue and to solve societal problems. In relation to this study, both senior high school teachers and students' knowledge of climate change

would be drawn from several disciplines in order to mitigate and adapt to the causes and effects of climate change respectively.

6. Social reconstructionists highlight the ethical and political dimensions of knowledge and its use by emphasising that schools "must be seen as places where culture, power, and knowledge come together to produce . . . a vision of the future," (Giroux, 2006, pp.4–5) a vision that determines what knowledge we consider to be true, ethical, emancipatory, and worthwhile.

The assertion made by Giroux (2006) is true to some extent that before knowledge can be true, ethical, emancipatory, and worthwhile, there must be an interaction of culture, power, and knowledge to help society achieve its aims and aspirations, solve societal problems and satisfy societal needs. This is so because culture, power, and knowledge individually does not help society to achieve its aims and aspirations unless they all come together as a whole for the betterment of society.

To another extent, Giroux (2006)'s assertion does not hold because the school is not the only medium through which culture, power, and knowledge can interact for the society to achieve its aims and aspirations. There are other platforms such as the religious organisations, the community, the peer group, the mass media and the like through which culture, power, and knowledge can interact for the society to achieve its future dreams.

Evaluation in social reconstructionism

Social reconstructionists do not usually use formal objective evaluation during curriculum development (McLaren, 2007). They primarily use subjective evaluation. They recommend a gestalt field theory approach to

the evaluation of both curricula and students. Questions asked are not of the form 'How does curriculum z or student y measure up to standard m?' but rather of the form 'How does curriculum z or student y measure up to standard m in a particular circumstance?' This is necessary because the particular time, place, and setting in which social crises are confronted are constantly changing, as are the students confronting them, and it is believed that the only valid assessments are those made under real-world circumstances. Evaluation is not a simple comparison of expected outcomes to achieved outcomes, but rather a comparison of the evaluee whether curriculum or student to both expectations and to the field in which the evaluee functions.

In the case of curriculum evaluation, this involves taking account of the social environment in which the curriculum is examined. In the case of student evaluation, this involves taking account of both the student's performance and the student's ability to perform (Schiro, 2007). For example, in evaluating a child's self-concept with respect to the variable 'power over environment,' one would use a function including the following parameters: the power the child exhibits, the power the child is capable of possessing, the power the child thinks other children have, and the power the child thinks he or she has. Here, the relation is between (1) the power the child possesses compared to the power available to him, and (2) the power the child thinks he has compared to the power he thinks he is capable of possessing.

For social reconstructionists, summative student evaluation and curriculum evaluation are inextricably tied together in the particular social environment in which students live (Schiro, 2007). Here, curriculum is evaluated through student performance outside of school. The same holds true

for student evaluation. What students learn is thought to be testable only in their everyday life outside of school as they work to reconstruct themselves and society in light of the curriculum's vision of the future good society. During instruction, and particularly during group discussions, teachers provide students with feedback about their meanings, meaning structures, perceptive functions, and interpretive functions. Thus for the purpose of helping students gain insight that will enable them to reconstruct and transform those meanings, meaning structures, perceptive functions, and interpretive functions and become more insightful and powerful in analysing, understanding, envisioning, and acting in social situations. Evaluation and feedback are for the purpose of aiding students in reconstructing themselves so that they can in turn aid in the reconstruction of society.

Learning in social reconstructionism

Social reconstructionists view learning from the perspective of constructivism. They regard learning as active assimilation of new experiences into learners' meaning structures in such a way as to force those meaning structures to accommodate to the new experiences (McLaren & Giroux, 1997). There are two significant components of this view of learning. The first hinges on the phrase 'meaning making': learning occurs when learners construct meaning out of their sensations. Learning is a process of actively assimilating and accommodating experience in such a way that it makes sense to the learner.

The second component of this view of learning depends on the concept of 'meaning structure': learning is based on what one already knows about the world, and it is meaningful only when it can be accommodated to one's

overall conception of reality. As a result, learning must happen in the context in which what is learned occurs and in terms of what one already knows. Thus, educators should construct curricula that draw upon the cultural resources that students bring with them to school. This suggests not only taking the languages, histories, experiences, and voices of students seriously, but also integrating what is taught in schools with the dynamics of everyday life. This points to developing curricula that address the real problems and concerns that students face on a local, societal, and global level (Giroux, 2006).

According to Giroux (2006), meaning making learners are viewed as active agents in their learning. Learning is not a passive process of incorporating objective reality into the mind by simple absorption. Learners actively choose from among their many sensory experiences those that they will become cognisant of (the perceptive function) and interpret those sensations into perceptions that have meaning in relation to their existing meaning structures (the interpretive function). Choosing which sensations to perceive and choosing how to interpret those perceptions are active functions on the part of learners and uniquely determined by their meaning structures (Giroux, 2006). The subjective reality learners come to know results from their personally impressing meaning onto objective reality.

It is important to note that what learners come to know is not nature itself but nature actively interpreted through such things as the structure and lexicon of their language. Learners incorporate into themselves the stimuli impinging on them by passing them through their perceptive and interpretive functions while applying meaning-giving filters to them such as their

language and modes of thinking. The medium (the mind) is the message (what one knows) in the sense that the operators governing the working of the mind actively mold psychological sensations into mental perceptions.

According to Schiro (2007), one learns in terms of what he or she already knows and in the context in which his or her learning occurs. First, it is believed that learning can take place only in relation to what one already knows. For experiences to make sense to a learner, they must be capable of being accommodated into the learner's meaning structure. This means that they must be of a form and contain a content that relates to both the learner's meaning structure and the totality of his or her past learning experiences. The mere occurrence of a 'psychological fact' does not result in learning. It is only when the occurrence is related to other phases of the learner's experience and capable of being related to and incorporated into the learner's meaning structure that learning occurs. It is, in fact, learners' meaning structures that give import to what they perceive. That is, whatever learners hear or see will be meaningful to them only on their own terms and not on the terms of the emitter of the information: what they learn will be a function of their past experiences, their assumptions, and their purposes and not those of the stimulator of their sensations.

Second, it is believed that, for valid meaning to be infused into anything, it must be learned in the context in which it occurs and in the context of a total pattern of events. The social reconstructionist's concern is not the acquisition and then organisation of unrelated atomistic facts but rather the learning of gestalts of occurrences in organic relatedness. To be

considered worthwhile, learning must be the product of insight into the patterns that relate the parts of an event to the total occurrence of the event.

The nature of learning has a number of important interrelated characteristics (Schiro, 2007). These are;

a. Learning is primarily a social act rather than an individual act. In both process and product, in both means and ends, it aims mainly at 'social self-realisation' (Brameld, 1950). Learning requires not only that a social group acquire knowledge but also that it reaches a consensus concerning both the nature and truth of that knowledge. Learning is always directed toward the achievement of social consensus or agreement. In fact, "the objective of the entire [learning] process is to attain a consensus upon which the group can depend and from which it can act" to reconstruct society (Brameld, 1950, p. 546).

b. Learning takes place in both classrooms and communities. It requires immersion in and interaction with a social group that "extends beyond the school proper into the community" (Brameld, 1950, p. 533). This means that curricula require two separate social settings for learning: inside and outside the school.

c. Learning takes place through language and communication, which include such things as group discussion, talking, singing, acting, sculpture, group processing, and value clarification (Schiro, 2007). From a practical point of view, learning through communication transforms the traditional classroom: Instead of communication being limited to the imparting of indirect evidence from textbooks, pictures, or lectures, learning takes place by the reciprocal expression among students and teachers alike. The effort to

articulate interests [feelings or thoughts] is encouraged and respected. Likewise, the effort to interpret all evidence provided by science, art, or history replaces the passive recitation, which does virtually nothing to bring such evidence into vital relationship with one's own experience. The more that genuine back-and-forth communication takes place, the more spontaneous it becomes, and the more facile and precise the meanings that emerge (Brameld, 1950).

d. Learning involves some form of direct experience: Fundamental to learning is the kind of evidence about one's wants which springs from his own experience, and of which himself become directly aware.

e. Learning is not limited to firsthand experiences, but social reconstructionists try to keep learning as close to firsthand experience as possible (Schiro, 2007). Thus, if a group is to learn something like history, of which they cannot have firsthand experiences, educators attempt to do such things as provide firsthand accounts of occurrences or engage students in simulations that approximate experiences.

f. Valuable learning requires not just thought, but also an emotional response to what is understood that includes commitment to a social position and action directed toward reconstructing society. Counts (1932) hints that learning has this tripartite nature of thought, commitment, and action when he writes that society requires learners who, while capable of gathering and digesting facts, are at the same time able to think in terms of life, make decisions, and act. In the language of the last quarter of the 20th century, learning requires praxis: reflection and action, in such radical interaction that if one is sacrificed, even in part, the other immediately suffers (Freire, 1970).

g. Learning requires interaction of learners with the environment outside themselves (Schiro, 2007). The learner must actively interact with someone or some situation to make meaning.

Constructivist theory of learning

Enquiry teaching and enquiry-based learning of climate change, are often viewed as constructivist approaches to learning. Boyce (cited in McEachron, 2001). The formalisation of the possibility of constructivism is generally ascribed to Piaget (1896-1980), who explained the instruments by which information is disguised by the student. He recommended that through cycles of assimilation and accommodation, people develop new knowledge from their encounters.

At the point when people absorb, they join new encounters into a generally existing structure without changing that system. This may happen when people's encounters are lined up with their inner portrayals of the planet, yet, can likewise happen as an inability to fluctuate a school understanding; for example, they will not see occasions, may misjudge contribution from others, or may conclude that an event might be an incident and is subsequently insignificant as data about the planet.

Interestingly, when people's encounters negate their inward portrayals, they may change their impression of the encounters to suit interior portrayals. Convenience is regularly perceived due to the system by which disappointment brings about learning: when individuals follow up on the assumptions, they much of the time fall flat, however by obliging this new experience and rethinking individuals' model of the manner in which the

planet works, individuals get familiar with the experience of disappointment or other's disappointment.

Note that constructivism is certifiably not a particular instructional method. Constructivism might be a hypothesis that depicts how learning occurs, regardless of whether students are utilising their encounters to know lectures or adhering to guidelines for building a model plane. In the two cases, the possibility of constructivism recommends that students develop knowledge out of their encounters. Notwithstanding, constructivism is typically identified with instructive methodologies that advance dynamic learning or learning by doing (McLeod, 2019).

In agreement to a constructivist viewpoint, educators do not need to educate within the standard feeling of conveying guidance to a group of scholars. Maybe they are to utilise materials with which students become effectively included through control, or social connection.

According to Osbergh (1997), the application of constructivism in the teaching and learning, has many implications: first, teachers should focus on the learners, how they comprehend content; second, what learners learn from a teacher's lesson depends much more on how learners are personally involved in the new content than on intrinsic nature of the content; third, teachers must develop lessons that focus on complete and fully developed conceptual situations; and fourth, teachers are required to assist their students to develop critical thinking skills which will enable them to construct their knowledge and understanding.

Osbergh (1997) further suggested that constructivist teaching should feature the following: instruction that focuses on depth instead of breadth,

enquiry-oriented instruction designed to assist learners in transfer information to situations beyond the context during which it is learned, encourage learners to vary their perspectives as a result of considering new information, and encourage co-operative or collaborative learning instead of individual learning. Exercises weight on perception, gathering information, summing up and testing theories, and managing others. The class should visit locales outside of the study hall, educators from various disciplines should design educational plans together, and learners ought to be instructed to act naturally directed, take energetic job in their learning by laying out objectives, checking and assessing progress, and going past fundamental necessities by investigating interests (Geary cited in Schunk, 2000).

The ongoing discussion on the constructivist theory of learning sometimes hold since the theory seems essential on everyday level. That is to say that it is a position which has been frequently adopted ever since people began to ponder on the theory of knowledge. On the other hand, the constructivist theory of learning is not always the case in the sense that when one is in favour of constructivist theory of learning (followers of Dewey, Piaget, Vygotsky, among others), one has to give up Platonic and all subsequent realistic views of the theory of knowledge. An individual has to recognise that there is no idea that knowledge in this world is independent of the knower, but knowledge can only be constructed as the individual learns.

Again, the constructivist theory of learning sometimes does not hold because learning is not necessarily understanding the true nature of things. Nor is it (as Plato suggested) remembering faintly supposed perfect ideas. But rather, a personal and social construction of meaning out of the confusing

collection of sensations which have no order or structure besides the explanations which a person intentionally arranges for them. The more important question is, 'does it actually make any difference in everyday work whether deep down in an individual, he or she will consider knowledge to be real in this world independent of others, or whether the person will consider knowledge to be of his or her own making'.

Concept of climate

The concept 'climate' relates to persistent study of the weather elements. In this regard, the public simply explains the term climate in terms of the weather. There is a basic distinction between weather and climate. The difference between weather and climate is a measure of time (NASA, 2005). The term climate means the average or mean conditions of weather elements over a long period of time, for example 30, and even 70 years. Weather on the other hand is the 'snap-shot'- the instantaneous changes, conditions, or the state of the atmosphere over a short period of time, for example, some few seconds, minutes, a day, or week (Acheampong, 2016).

Weather is basically the way the atmosphere is behaving, mainly with respect to its effects upon life and human activities. The weather consists of the short-term (minutes to months) changes in the atmosphere. Most people think of weather in terms of temperature, humidity, precipitation (rainfall, snow, hail), cloudiness, brightness, visibility, wind and atmospheric pressure, as in high and low pressure (NASA, 2005).

Climate is a measure of the average pattern of variation in temperature, humidity, atmospheric pressure, wind, precipitation, atmospheric particle count and other meteorological variables in a given region over long periods

of time (Study Mode Research, 2021). Climate is different from weather, in that, weather only describes the short-term conditions of these variables in a given region. A region's climate is generated by the climate system, which has five components: atmosphere, hydrosphere, cryosphere, land surface and biosphere. The climate of a location is affected by its latitude, terrain, altitude, as well as nearby water bodies and their currents (Study Mode Research, 2021). Climate differs spatially, for example, depending on the distance from the equator or the sea, and temporally, for example, depending on seasonal and daily variations.

Climate change

Climate change is one of the major difficulties in the world and adds considerable stress to societies and to the environment. From shifting weather patterns that threaten food production, to rising sea levels that increase the risk of catastrophic flooding, the impacts of climate change are global in scope and unprecedented in scale. Without drastic action today, adapting to these impacts in the future will be more difficult and costly (UNEP, 2009). This has prompted scientists, researchers, educationists, policy makers and governments to give this global phenomenon the desired attention.

Evans and Steven (2007) admit that the first World Climate Conference was held in 1979, and the Second in 1990. The IPCC was set up in 1988 and its first report was produced two years later. In recognition of the negative impact of climate change is the institution of the Kyoto Protocol (1997) which is an environmental treaty to the United Nations Framework Convention on Climate Change (UNFCCC). Its aim is to fight global warming by achieving stabilisation of the greenhouse gas concentrations in the

atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

Another earlier protocol is the Montreal Protocol (1985) on substances that deplete the ozone layer. This is a protocol to the Vienna Convention and also an intergovernmental treaty designed to protect the ozone layer by phasing out numerous substances believed to be responsible for ozone depletion. Other protocols include the Helsinki Protocol (1989) which addressed issues of carbon dioxide emissions, and required 30% cut by 1993 and the Sofia Protocol, which targeted reduction of nitrogen oxides (Anijah-Obi, 2001). A more recent attempt at addressing the issue is the Copenhagen Climate Council, which brought councillors together to create global awareness of the importance of the UN Climate Summit (COP15) in Copenhagen in December, 2009. This was to ensure technical and public support and assistance to global decision makers as they agree on a new climate treaty to replace the Kyoto Protocol from 1997 (UNESCO, 2010).

All these efforts have resulted in very useful contributions to the issue of climate change. Unfortunately, a lot of greenhouse gases have already been produced and emitted into the environment such that even if the process is halted immediately, there will still be changes to the climate. This, in effect, presupposes that if humanity is to respond to the changes, education has a key role to play in the knowledge level and helping individuals, society and governments to make informed choices. This is not simply about giving people information, but ensuring that education and schools specifically, are mobilised to re-orient society towards sustainable practice. There is thus the

need for mitigation, in which any action designed is to reduce the anticipated or actual conditions related to climate change.

For most people, the expression 'climate change' means the alteration of the world's climate that we humans are causing, through fossil fuel burning, clearing forests and other practices that increase the concentration of greenhouse gases (GHG) in the atmosphere (IPCC Fourth Assessment Report, Working Group I, 2007). This is in line with the official definition by the United Nations Framework Convention on Climate Change (UNFCCC) that climate change is the change that can be attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (UNFCCC, 2007).

Climate change in IPCC usage refers to a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC) which attributes climate change directly or indirectly to human activities.

The IPCC's definition recognises both human activities and natural phenomena as the driving forces behind climate change. Again, climate change is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years. It may be a change in average weather conditions, or in the distribution of

weather around the average conditions, that is, more or fewer extreme weather events (IPCC, 2007).

Climate change is a long-term shift in the climate of a specific location, region or planet. The shift is measured by changes in features associated with average weather, such as temperature, wind patterns and precipitation (rainfall, snow, hail) (Climate Change Fact Sheet, 2013). What most people do not know is that a change in the variability of climate is also considered climate change, even if average weather conditions remain the same. Climate change occurs when the climate of a specific area or planet is altered between two different periods of time. This usually occurs when something changes the total amount of the sun's energy absorbed by the earth's atmosphere and surface. It also happens when something changes the amount of heat energy from the earth's surface and atmosphere that escapes to space over an extended period of time. Such changes can involve both changes in average weather conditions and changes in how much the weather varies around these averages (Climate Change Fact Sheet, 2013).

The changes can be caused by natural processes like volcanic eruptions, variations in the sun's intensity, or very slow changes in ocean circulation or land surfaces which occur on time scales of decades, centuries or longer. But humans also cause climates to change by releasing greenhouse gases and aerosols into the atmosphere, by changing land surfaces, and by depleting the stratospheric ozone layer. Both natural and human factors that can cause climate change are called 'climate forcings', since they push, or 'force' the climate to shift to new values (Climate Change Fact Sheet, 2013).

It must be emphasised, however, that the concept 'climate change' is different from 'global warming' but sometimes people use the two interchangeably. It is important at this point to clarify this for the purpose of this work. Strictly speaking, global warming is just one aspect of climate change, and is indeed an important driver of climate change. Apparently small increases in average global temperatures can lead to very large changes in other aspects of local and global climates. Changes in these other aspects of the climate - in averages in precipitation, winds, clouds, humidity, and in temporal and spatial variation and variability - may then have multiple impacts. Since global warming may also be accompanied by local or temporary falls in average temperature, the term climate change is a more accurate description of the problem the world faces.

Climate change refers to general shifts in climate, including temperature, precipitation, wind and other factors. Global warming (as well as global cooling) refers specifically to any change in the global average surface temperature. Global warming is often misunderstood to imply that the world will warm uniformly. In fact, an increase in average global temperature will also cause the circulation of the atmosphere to change, resulting in some areas of the world warming more than others. Some areas can even cool.

Unfortunately, although it significantly misrepresents what really happens, the term 'global warming' is still often used by media and others to describe climate change (Climate Change Fact Sheet, 2013, p.1). Global Warming also describes the average temperature of the earth's oceans, land and atmosphere. The individual measurements are from a very large, international network of weather observations, and typically averaged on a

yearly basis. It also relates to the general increase in the earth's near-surface air and ocean temperatures (IPCC, 2007).

Evidence of climate change

Climate change is one of the defining issues of our time. It is now more certain than ever, based on many lines of evidence, that humans are changing earth's climate. The atmosphere and oceans have warmed, which has been accompanied by sea level rise, a strong decline in Arctic sea ice, and other climate-related changes. The impacts of climate change on people and nature are increasingly apparent. Unprecedented flooding, heat waves, and wildfires have cost billions in damages.

Habitats are undergoing rapid shifts in response to changing temperatures and precipitation patterns. It is for this reason that the Royal Society and the US National Academy of Sciences, with their similar missions to promote the use of science to benefit society and to inform critical policy debates, produced the original 'Climate Change: Evidence and Causes' in 2014. It was written and reviewed by a UK-US team of leading climate scientists. This new edition, prepared by the same author team, has been updated with the most recent climate data and scientific analyses, all of which reinforce our understanding of human-caused climate change. The evidence is clear.

However, due to the nature of science, not every detail is ever totally settled or certain. Nor has every pertinent question yet been answered. Scientific evidence continues to be gathered around the world. Some things have become clearer and new insights have emerged. For example, the period of slower warming during the 2000s and early 2010s has ended with a

dramatic jump to warmer temperatures between 2014 and 2015. Antarctic sea ice extent, which had been increasing, began to decline in 2014, reaching a record low in 2017 that has persisted. These and other recent observations have been woven into discussions. Calls for action are getting louder.

The 2020 Global Risks Perception Survey from the World Economic Forum ranked climate change and related environmental issues as the top five global risks likely to occur within the next ten years. Yet, the international community still has far to go in showing increased ambition on mitigation, adaptation, and other ways to tackle climate change. Scientific information is a vital component for society to make informed decisions about how to reduce the magnitude of climate change and how to adapt to its impacts.

Causes of climate change

The earth's climate has varied considerably in the past, as shown by the geological evidence of ice ages and sea level changes, and by the records of human history over many hundreds of years. The causes of past changes are not always clear but are generally known to be related to changes in ocean currents, solar activity, volcanic eruptions and other natural factors (UNISDR, 2009). The difference now is that global temperatures have risen unusually rapidly over the last few decades. There is strong evidence of increases in average global air and ocean temperatures, widespread melting of snow and ice, and rising average global sea levels. The IPCC Fourth Assessment Report concludes that the global warming is unequivocal. It further posits that increasing concentration of greenhouse gases is accountable for most of the observed temperature increase since the middle of the 20th century. Atmosphere and ocean temperatures are higher than they have been at any

other time during at least the past five centuries, and probably for more than a millennium (UNISDR, 2009).

The current concentration of greenhouse gases in the atmosphere is now the highest it has been for the past 500,000 years, having grown by 70% between 1970 and 2004 alone, and having reached this level exceptionally quickly (IPCC, 2007). Scientists have long known that the atmosphere's greenhouse gases act as a 'blanket' which traps incoming solar energy and keeps the earth's surface warmer than it otherwise would be, and that an increase in atmospheric greenhouse gases would lead to additional warming (UNISDR, 2009). While there has been some controversy in the past, it is now widely accepted that human activities, in particular fossil fuel use and changing land-uses, are the dominant factors in this growth and are responsible for most of the warming observed over the past 50 years (UNISDR, 2009).

Verlag and Muller (1992) stated that chief among the causes of climate change are greenhouse gases which result mainly from human activities. They further point out that "worldwide, the use of fossil fuels, coal, oil and gas for energy purpose accounts for 50% of the additional man-made greenhouse effect" (p. 57). The situation is exacerbated by the destruction of forest ecosystems which play an important role in the absorption of carbon dioxide from the atmosphere. Most climate scientists agree, however, that the main cause of the current global warming trend is human expansion of the 'greenhouse effect'- warming that result when the atmosphere traps heat radiating from earth toward space. Certain gases in the atmosphere block heat from escaping. Long-lived gases, remaining semi-permanently in the

atmosphere, which do not respond physically or chemically to changes in temperature, are described as 'forcing' climate change whereas gases, such as water, which respond physically or chemically to changes in temperature are seen as 'feedbacks' (IPCC, 2007).

Once more, the crucial component that causes greenhouse gases such as Carbon Dioxide, Methane, Chlorofluorocarbons (CFC's) and Nitrous Oxide to be released into the atmosphere is human activity. The burning of fossil fuels (i.e., non-renewable resources such as oil, coal and natural gas) has a significant effect on the warming of the atmosphere. The heavy use of power plants, cars, airplanes, buildings and other man-made structures release carbon dioxide into the atmosphere and contribute to global warming (Nicole, 2012). Greater amounts of these emissions emanate from the industrialised nations and are reaching alarming proportions. The quest for industrialisation and urbanisation is the trigger causes of the greater demand for energy and its attendant effects.

Verlag and Muller (1992) are in support of industrialisation as the cause of climate change by stating that in 1989, global energy-related carbon dioxide emissions amounted to 21.6 billion tons. The industralised nations were responsible for three quarters of those emissions, with the Organisation for Economic Cooperation and Development (OECD) countries accounting for 47 percent (or 10 billion tons of carbon dioxide) and the industrialised, former centrally planned economies accounting for 25 per cent of the total emissions. Nylon and nitric acid production, the use of fertilisers in agriculture, and the burning of organic matter also release the greenhouse gas

Nitrous Oxide (Nicole, 2012). These are processes that have been expanded since the mid-twentieth century.

Gases that contribute to the greenhouse effect include: Water vapour, the most abundant greenhouse gas, acts as a feedback to the climate. Water vapour increases as the earth's atmosphere warms, but so does the possibility of clouds and precipitation, making these some of the most important feedback mechanisms to the greenhouse effect (NASA, 2015). Carbon dioxide, a minor but very important component of the atmosphere, is released through natural processes such as respiration and volcano eruptions and through human activities such as deforestation, land use changes, and burning fossil fuels. Humans have increased atmospheric carbon dioxide concentration by a third since the Industrial Revolution began. This is the most important long lived 'forcing' of climate change (NASA, 2015).

Carbon dioxide provides the dominant means through which carbon is transferred in nature between a number of natural carbon reservoirs - a process known as the carbon cycle. Human beings contribute to this cycle every time there is breathing. Using the oxygen we take in from the atmosphere, carbon from our food is burnt and turned into carbon dioxide that we then exhale; in this way we are provided with the energy we need to maintain our life. Since carbon dioxide is a good absorber of heat radiation coming from the earth's surface, increased carbon dioxide acts like a blanket over the surface, keeping it warmer than it would otherwise be. This increase in global temperature will lead to global climate change (Houghton, 2004).

Methane, a hydrocarbon gas is produced both through natural sources and human activities, including the decomposition of wastes in landfills,

agriculture, and especially rice cultivation, as well as ruminant digestion and manure management associated with domestic livestock. On a molecule-for-molecule basis, methane is a far more active greenhouse gas than carbon dioxide, but also one which is much less abundant in the atmosphere. That is, the enhanced greenhouse effect caused by a molecule of methane is about eight times that of a molecule of carbon dioxide. Nitrous oxide, a powerful greenhouse gas is produced by soil cultivation practices, especially the use of commercial and organic fertilisers, fossil fuel combustion, nitric acid production, and biomass burning (NASA, 2015).

Chlorofluorocarbons (CFCs), a synthetic compound which is entirely of industrial origin is used in a number of applications, but now largely regulated in production and released to the atmosphere by international agreement for their ability to contribute to destruction of the ozone layer are also greenhouse gases (NASA, 2015). The CFCs are man-made chemicals which, because they vaporise just below room temperature and because they are non-toxic and non-flammable, appear to be ideal for use in refrigerators, the manufacture of insulation and aerosol spray cans. Since they are so chemically un-reactive, once they are released into the atmosphere they remain for a long time before being destroyed.

Depletion of the ozone element available at the stratosphere is another important cause of climate change. Chlorofluorocarbons and halons are mainly responsible for this depletion. Verlag and Muller (1992) assert that these two gases are highly inert chemical compounds which are broken down almost exclusively by photo decomposition in the stratosphere, hence, their ozone depletion on global warming potentials. This gives an impression that

the more these CFCs are released into the atmosphere, the higher the rate at which global warming would occur since it will act as a catalyst in speeding up global warming leading to climate change.

In Ghana, the human activities that trigger climate change include burning of fossil fuel, especially petroleum products in vehicles, generators and other industrial machines. There is a phenomenal increase in the number of vehicles in towns and cities, a number of which are imported second hand vehicles (Obeng, 2012). Besides, the inefficient power supply system in the country has resulted in the increasing use of generators. Increase in the number and use of vehicles and generators, coupled with poor servicing record of owners, result in the production of a lot of smoke which increases the carbon dioxide concentrations. Secondly, the indiscriminate bush burning for hunting and farming purposes also add to the production of greenhouse gases because deforestation increases the carbon dioxide concentrations since plants and trees which make use of it are destroyed (Obeng, 2012).

Again, illegal mining activities lead to the pollution of the land and water bodies and sometimes to the extinction of water bodies. This affects the rainfall cycle. Also, indiscriminate dumping of refuse which degrades the land and kills water bodies, and in addition causes the release of large amounts of methane gas-CH_4 into the atmosphere. Not all, use of imported old refrigerators and air conditioners which contain chlorofluorocarbons (CFC's) as coolants. These equipment are not properly disposed off when they are no longer in use and the gases leak out into the atmosphere (Forster et al., 2007). It can be inferred from the ongoing discussions that, continuous warming of the globe by rapid release of greenhouse gases such as carbon dioxide,

methane, nitrous oxide and CFC's as well as depletion of the ozone layer in the stratosphere directly or indirectly by human initiative and by physical factors are the major causes of climate change.

Climate change impacts

Climate change impacts are described with increasing confidence by IPCC (2007). These impacts might be direct (e.g., changes in agricultural potential caused by rainfall change or inundation of cities and infrastructure due to sea level rise and higher disease burden) or they might be indirect (e.g., through effects of climatic change on world market prices of agricultural and fisheries products). The physical impacts are increases in the already high temperatures which lead to large evaporation losses and in many developing countries precipitation is not likely to increase as is expected in many high-latitude regions (Christensen et al., 2007). Secondly, many developing countries, in terms of national income and employment, rely heavily on agriculture that is directly affected by climatic change and the high number of poor people are generally more vulnerable and likely to feel the negative effects of climate change (Yohe & Tol, 2002).

Expressed as a global average, surface temperatures have increased by about 0.74°C over the past 100 years (Trenberth et al., 2007). However, the largest share of the increase (0.55°C) has occurred over the past 30 years. The largest temperature increases have occurred over land and in the arctic and subarctic regions. The observed temperature increases over the past 30 years in large parts of Africa, Asia, and Latin America are generally within the range of 0.5°C to 1.0°C, although there are regions with larger observed changes (e.g., in southeastern Brazil and North Asia) (Cruz et al., 2007;

Magrin et al., 2007; Trenberth et al., 2007). Surface air temperatures over land have risen by about double the rate of temperatures over the ocean, which means that less warming has occurred in small island states (e.g., in the Pacific).

Consistent with the warming, there has been an increase in the frequency of warm extremes (Trenberth et al., 2007). Downward trends in precipitation have been observed in the tropics from 10 S to 30 N since the 1970s (Trenberth et al., 2007). It has become wetter in eastern parts of South America and northern and central Asia but drier in the Sahel, southern Africa, and parts of southern Asia. In accordance with this, more intense and longer droughts have been observed over wider areas since the 1970s, mostly in the dry tropics and subtropics (Dai et al., 2004). These droughts have often been linked with prolonged heat waves. There have been substantial increases in heavy precipitation events in many land regions, even in regions with no change or reductions in total rainfall (Groisman et al., 2005), where droughts might be exacerbated if the reduced rainfall is increasingly falling in heavy precipitation events.

Globally, estimates of potential destructiveness of tropical cyclones show a significant upward trend since the mid-1970s (Emanuel, 2005), with a trend toward longer lifetimes and greater storm intensity (Emanuel, 2005). This is strongly correlated with the higher tropical sea surface temperatures. Even though these observations depend critically on data quality and the choice of start date (Chan, 2006), the data available suggest that the potential destructiveness has not previously been as high as now (Trenberth et al., 2007).

The largest increases in intense tropical cyclones have been observed in the North Pacific, Indian, and southwest Pacific Oceans (Trenberth et al., 2007).

Observations of changes in physical and biological systems across the globe are consistent with the observed changes in climate (Rosenzweig et al., 2007). Particularly large effects are related to enhanced glacial melt affecting river flows and to changes in phenology and productivity of biological systems as affected by temperature and rainfall changes.

Climate change mitigation

One of the two major approaches to addressing the impacts of climate change is mitigation. Broadly, mitigation involves efforts to slow, stabilise, or reverse climate change itself. When I refer to climate change mitigation in this thesis, I am referring to actions taken to lessen the causes of climate change. Mitigation requires behavior change on local, national, and global levels by individuals, business, scientists, governments, non-government organisations, and other social and economic players. Mitigation efforts include direct intervention in the environment, such as replacing eroding beaches, and intervention in the human causes of climate change, such as programs to decrease greenhouse gas emissions. Mitigation is necessary to slow down the numerous and widespread effects of climate change and to prevent other effects from occurring.

Climate change mitigation consists of actions to limit the magnitude or rate of global warming and its related effects (Fischer et al., 2007). This generally involves reductions in human (anthropogenic) emissions of greenhouse gases (GHGs) (IPCC, 2007). Fossil fuels account for about 70% of GHG emissions (GHG Emissions). The main issue is their substitution with

low-carbon energy sources. Due to massive price drops, wind energy and solar are increasingly out-competing oil, gas and coal (International Renewable Energy Agency [IRENA], 2017). Similarly, Harvey (2019) is of the view that some of the reasons for phasing-out fossil fuels are the mitigation of climate change, and the falling cost of renewable energy.

This means that since the prices of wind energy and solar are lower than the prices of oil, gas and coal, it has helped in the mitigation of climate change because the pollution attached to the production of oil, gas and coal (that is, fossil fuel production which leads to the emission of carbon dioxide into the atmosphere) has reduced. This is because the demand for wind energy and solar is high as compared to oil, gas and coal. Mitigation may also be achieved by increasing the capacity of carbon sinks, for example through reforestation (IPCC, 2007). Mitigation policies can substantially reduce the risks associated with human-induced global warming (Oppenheimer et al., 2014).

Similarly, Global Climate Change Vital Signs of the Planet (2020) is of the view that climate change mitigation is reducing emissions of and stabilising the levels of heat-trapping greenhouse gases in the atmosphere, either by reducing sources of these gases (for example, the burning of fossil fuels for electricity, heat or transport) or enhancing the 'sinks' that accumulate and store these gases (such as the oceans, forests and soil). The goal of mitigation is to control significant human interference with the climate system, and "stabilise greenhouse gas levels in a timeframe sufficient to allow ecosystems to adapt naturally to climate change, ensure that food production is not threatened and to enable economic development to proceed in a

sustainable manner" (IPCC, 2014, p. 4). This assertion implies that in order for the economic affairs of a country to improve, there is the need for people to lessen the causes of climate change through the various mitigation strategies and the question is how many people have knowledge on that?

Global Environment Facility Investigating in Our Planet (2020) is also of the view that mitigating climate change is about reducing the release of greenhouse gas emissions that are warming our planet. Mitigation strategies include retrofitting buildings to make them more energy efficient; adopting renewable energy sources like solar, wind and small hydro; helping cities develop more sustainable transport such as bus rapid transit, electric vehicles, and biofuels; and promoting more sustainable uses of land and forests. About 1.4 billion people around the world rely on traditional fuels like coal and wood to meet their basic energy needs. This is not only harmful to the environment; it can also lead to premature deaths for millions of people, especially women and children. By 2035, global energy demand is projected to grow by more than 50 percent, and even faster in developing countries (Global Environment Facility Investigating in our Planet, 2020). All these new consumers need clean energy that will not hurt them or the environment.

Other examples of mitigation include reducing energy demand by increasing energy efficiency and removing carbon dioxide from earth's atmosphere (IPCC, 2007). Climate engineering is discussed as another theoretical approach in long-term projections (UK Royal Society, 2009). Climate change mitigation measures can be written down in national environmental policy documents of countries (for instance the Nationally Determined Contributions (NDC) under the Paris Agreement).

According to the IPCC's 2014 assessment report, Mitigation is a public good; climate change is a case of the 'tragedy of the commons'. Effective climate change mitigation will not be achieved if each agent (individual, institution or country) acts independently in its own selfish interest (International Cooperation and Emissions trading), suggesting the need for collective action. This presupposes that each agent should collaborate with one another and work for effective climate change mitigation.

Almost all countries are parties to the United Nations Framework Convention on Climate Change (UNFCCC, 2013). The ultimate objective of the UNFCCC is to stabilise atmospheric concentrations of GHGs at a level that would prevent dangerous human interference with the climate system (UNFCCC, 2002). In 2010, parties to the UNFCCC agreed that future global warming should be limited to below 2°C (3.6°F) relative to the pre-industrial level (UNFCCC, 2011). With the Paris Agreement of 2015 this was confirmed, but was revised with a new target that 'parties will do the best' to keep warming below 1.5°C (Sutter & Berlinger, 2015). The current trajectory of global greenhouse gas emissions does not appear to be consistent with limiting global warming to below 1.5° C or 2°C (Harvey, 2019; UNFCCC, 2019 & Victor et al., 2014).

Other mitigation policies have been proposed, some of which are more modest (Nordhaus, 2010 & van Vuuren et al., 2011) than the 2°C limit. In 2019, after two years of research, scientists from Australia, and Germany presented the 'One Earth Climate Model' showing how temperature increase can be limited to 1.5°C for 1.7 trillion dollars a year (Chow, 2019 & One Earth Climate, 2020).

One of the issues often discussed in relation to climate change mitigation is the stabilisation of greenhouse gas concentrations in the atmosphere. The United Nations Framework Convention on Climate Change (UNFCCC) has the ultimate objective of preventing 'dangerous' anthropogenic (i.e., human) interference with the climate system. As is stated in Article 2 of the Convention, this requires that greenhouse gas (GHG) concentrations are stabilised in the atmosphere at a level where ecosystems can adapt naturally to climate change, food production is not threatened, and economic development can proceed in a sustainable fashion (Rogner et al., 2007).

There are a number of anthropogenic greenhouse gases. These include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and a group of gases referred to as halocarbons. Another greenhouse gas, water vapor, has also risen as an indirect result of human activities (Forster et al., 2007). The emissions reductions necessary to stabilise the atmospheric concentrations of these gases varies. Carbon dioxide is the most important of the anthropogenic greenhouse gases (IPCC, 2007). There is a difference between stabilising CO_2 emissions and stabilising atmospheric concentrations of CO_2 (Granger et al., 2009). Stabilising emissions of CO_2 at current levels would not lead to stabilisation in the atmospheric concentration of CO_2. In fact, stabilising emissions at current levels would result in the atmospheric concentration of CO_2 continuing to rise over the 21st century and beyond. The reason for this is that human activities are adding CO_2 to the atmosphere faster than natural processes can remove it (IPCC, 2007).

According to some studies, stabilising atmospheric CO_2 concentrations would require anthropogenic CO_2 emissions to be reduced by 80% relative to the peak emissions level (US NRC, 2011). An 80% reduction in emissions would stabilise CO_2 concentrations for around a century, but even greater reductions would be required beyond this (US NRC, 2011). Other research has found that, after leaving room for emissions for food production for nine billion people and to keep the global temperature rise below 2°C, emissions from energy production and transport will have to peak almost immediately in the developed world and decline at about 10% each year until zero emissions are reached around 2030 (Anderson, 2012; Anderson & Bows, 2011; Anderson & Bows, 2012 & The Radical Emission Reduction Conference, 2013).

In 2018, an international team of scientist published research saying that the current mitigation policy in the Paris Agreement is insufficient to limit the temperature rise to 2 degrees. They say that even if all the current pledges are accomplished there is a chance of a 4.5° temperature rise in decades. To prevent that, restoration of natural carbon sinks, carbon dioxide removal, and changes in society and values will be necessary (Steffen et al., 2018).

In 2019, a report was published by the United Nations saying that to limit the temperature rise to 2 degrees, the world will need to cut emissions by 2.7% each year from 2020 to 2030, and triple the climate targets. To limit the temperature rise to 1.5 degrees, the world would need to cut emissions by 7.6% each year from 2020 to 2030 and increase its climate commitments five-fold. Even if all the Paris Agreement pledges as they are in 2019 are fulfilled,

the temperature will rise by 3.2 degrees this century (Harvey, 2019 & UN Report, 2019). A report published in September 2019 before the 2019 UN Climate Action Summit, says that the full implementation of all pledges made by international coalitions, countries, cities, regions and businesses (not only those in the Paris Agreement) will be sufficient to limit temperature rise to 2 degrees but not to 1.5 degrees. Additional pledges were made in the September climate summit and in December (UNFCCC, 2019). All the information about the pledges is sent to the Global Climate Action Portal - Nazca. The scientific community is checking their fulfillment (UNFCCC, 2019).

Assessments often suggest that GHG emissions can be reduced using a portfolio of low-carbon technologies (IPCC, 2007). At the core of most proposals is the reduction of greenhouse gas (GHG) emissions through reducing energy waste and switching to low-carbon power sources of energy. As the cost of reducing GHG emissions in the electricity sector appears to be lower than in other sectors, such as in the transportation sector, the electricity sector may deliver the largest proportional carbon reductions under an economically efficient climate policy (Issues in Science, 2013).

Economic tools can be useful in designing climate change mitigation policies (IPCC, 2014). Abolishing fossil fuel subsidies is very important but must be done carefully to avoid making poor people poorer. Other frequently discussed means include efficiency, public transport, increasing fuel economy in automobiles (which includes the use of electric hybrids), charging plug-in hybrids and electric cars by low-carbon electricity, making individual changes, (IPCC, 2007) and changing business practices. Replacing gasoline

and diesel vehicles with electric implies that their emissions would be displaced away from street level, where they cause illness. Increased use of electricity could be met through low-carbon sources such as renewables and nuclear.

A range of energy technologies may contribute to climate change mitigation (IPCC, 2007). These include nuclear power and renewable energy sources such as biomass, hydroelectricity, wind power, solar power, geothermal power, ocean energy, and; the use of carbon sinks, and carbon capture and storage. Political and social attitudes may affect how easy or difficult it is to implement effective policies to reduce emissions (IPCC, 2001).

According to NASA, practical alternative sources of energy to power our needs such as wind, waves, sun and biofuels will help mitigate climatic changes. NASA's study showed that biofuel produces fewer and smaller soot particles than standard jet fuel. That would reduce aviation's contribution to global warming in ways beyond the possible effect on contrails and cirrus clouds. Replacing fossil fuel with biofuel also reduces the amount of carbon dioxide that is added to the atmosphere. Growing plants absorb CO_2 from the air.

In 2008, James Hansen and nine other scientists published a journal article titled "Target atmospheric CO_2 : Where should humanity aim?" which calls for a complete phase-out of coal power by 2030 (Chow, 2019). More recently, Hansen has stated that continued opposition to nuclear power threatens humanity's ability to control dangerous climate change (IPCC, 2007). The letter, co-authored with other climate change experts declared "If

we stay on the current path," he said, "those are the consequences we'll be leaving to our children. The best candidate to avoid that is nuclear power. It's ready now. We need to take advantage of it." and "Continued opposition to nuclear power threatens humanity's ability to avoid dangerous climate change."

Also in 2008, Pushker Kharecha and James Hansen published a peer-reviewed scientific study analysing the effect of a coal phase-out on atmospheric carbon dioxide (CO_2) levels (Rogner et al., 2007). Their baseline mitigation scenario was a phase out of global coal emissions by 2050. The authors describe the scenario as follows:

The second scenario, labeled Coal Phase-out, is meant to approximate a situation in which developed countries freeze their CO_2 emissions from coal by 2012 and a decade later developing countries similarly halt increases in coal emissions. Between 2025 and 2050, it is assumed that both developed and developing countries will linearly phase out emissions of CO_2 from coal usage. Thus in Coal Phase-out, we have global CO_2 emissions from coal increasing 2% per year until 2012, 1% per year growth of coal emissions between 2013 and 2022, flat coal emissions for 2023–2025, and finally, a linear decrease to zero CO_2 emissions from coal in 2050. These rates refer to emissions to the atmosphere and do not constrain consumption of coal, provided the CO_2 is captured and sequestered. Oil and gas emissions are assumed to be the same as in the BAU [business as usual] scenario.

Kharecha and Hansen cited in (Rogner et al., 2007) also consider three other mitigation scenarios, all with the same coal phase-out schedule but each making different assumptions about the size of oil and gas reserves and the

speed at which they are depleted. Under the Business-as-Usual scenario, atmospheric CO_2 peaks at 563 parts per million (ppm) in the year 2100. Under the four coal phase-out scenarios, atmospheric CO_2 peaks at 422-446 ppm between 2045 and 2060 and declines thereafter. The key implications of the study are as follows: a phase-out of coal emissions is the most important remedy for mitigating human-induced global warming; actions should be taken toward limiting or stretching out the use of conventional oil and gas; and strict emissions-based constraints are needed for future use of unconventional fossil fuels such as methane hydrates and tar sands.

A September 2016 report by Oil Change International, concludes that the carbon emissions embedded in the coal, oil, and gas in currently working mines and fields, assuming that these run to the end of their working lifetimes, will take the world to just beyond the 2°C limit contained in the 2015 Paris Agreement and even further from the 1.5°C goal (Anderson, 2012; Anderson & Bows, 2012 & The Radical Emission Reduction Conference, 2013). The report observes that 'one of the most powerful climate policy levers is also the simplest: stop digging for more fossil fuels' (The Radical Emission Reduction Conference, 2013).

In October 2016, the Overseas Development Institute (ODI) and 11 other NGOs released a report on the impact of building new coal-fired power plants in countries where a significant proportion of the population lacks access to electricity. The report concludes that, on the whole, building coal-fired power plants does little to help the poor and may make them poorer. Moreover, wind and solar generation are beginning to challenge coal on cost (Harvey, 2019; Steffen et al., 2018 & UN Report, 2019).

The Green Climate Fund (GCF-7) climate change mitigation strategy aims to support developing countries to make transformational shifts towards low-emission development pathways compatible with the objectives of the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement. Within the evolving landscape of climate finance, the strategy is designed to be as complementary as possible to other sources of climate finance, such as the Green Climate Fund. Green Climate Fund support for climate change mitigation efforts is informed by three overarching objectives:

1. Promote innovation and technology transfer for sustainable energy breakthroughs: Technology is one of the key means to reduce or slow the growth of and stabilise the concentration of greenhouse gas emissions (GHG). To that end, technology innovation, especially when promoted in partnership with the private sector, can help create or expand markets for green products and services, generating jobs, and supporting economic growth, while contributing to the reduction of Green House Gases emissions. Resources from the GCF play a key role in piloting emerging and innovative solutions, including clean technologies, business models, supportive policies and strategies, and financial tools which foster private sector engagement for climate-friendly technologies and innovations. Four entry points have been prioritised for GCF-7 support in the climate mitigation area, in consideration of their innovative nature and complementary to other financial mechanisms:

i. de-centralised renewable power with energy storage

ii. electric drive technologies and electric mobility

iii. accelerating energy efficiency adoption

iv. cleanstech innovation.

2. Demonstrate mitigation options with systemic impacts: Climate change affects virtually all natural and economic systems. The interaction between climate change and all areas of the GCF's work points to the importance of recognising climate change implications in other focal areas by harnessing mitigation options and integrating climate resilience measures, while promoting multiple global environmental benefits in a holistic and integrated fashion. This will be done via the three GCF-7 cross-cutting Impact Programs: Sustainable Cities; Food Systems, Land Use and Restoration; and Sustainable Forest Management.

3. Mainstreaming mitigation concerns into sustainable development strategies: The GCF continues to address the need for enabling conditions to mainstream climate change concerns into the national planning and development agenda through sound data, analysis, and policy frameworks. This is exemplified by the GCF support for National Communications, Biennial Update Reports, Technology Needs Assessments, Nationally Determined Contributions and the Capacity-building Initiative for Transparency through sound data, analysis, and policy frameworks.

The GCF has provided at least US$4.2 billion and leveraged $38.3 billion from other sources for more than 1,000 mitigation projects and programs in over 160 countries. We support a wide variety of mitigation strategies, but production and consumption of energy is the single largest contributor to greenhouse gas emissions. The GCF investments are geared to mitigate these emissions through specific projects. For example:

i. Energy efficiency: introducing standards for consumer appliances and equipment, such as lighting, air conditioners and motors, and stronger building codes.

ii. Renewable energy: commercialising and scaling technologies like solar, wind, small hydro, biopower and geothermal energy.

iii. Policy: introducing feed-in tariffs, reverse auctions and other market-based mechanisms and financial instruments to speed up investments in clean energy.

The preceding discussion indicates that efforts have been made both on the international and local levels to mitigate the causes of climate change yet still the phenomenon is occurring. The question one will ask, 'is the continuous existence of climate change as a result of the fact that many people do not know much about the causes of climate change or if they know, are demographic characteristics of both teachers and learners influencing their knowledge so that they can help mitigate the phenomenon?' So, there is the need for this study.

Climate change adaptation

The UN defines adaptation as adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts (UNFCCC, 2014). The UNFCCC (2014)'s definition of climate change adaptation is in line with the IPCC (2014)'s definition of climate change adaptation. Which states that, adaptation is the introduction of programs, policies, measures, or actions of governments, corporations, individuals, or other entities, in order to prevent or minimise, or to beneficially utilise the impacts of climate change. Adaptation needs are

circumstances requiring information, resources, and action to ensure safety of populations and security of assets in response to climate impacts.

The 2014 IPCC report also refers to adaptation options, as the array of strategies and measures available and appropriate to address needs. The report goes on to state that identifying needs and selecting and implementing options require the engagement of individuals, organisations, and governments at all levels and that the capacity to adapt is dynamic and influenced by economic and natural resources, social networks, entitlements, institutions and governance, human resources, and technology. Also, adaptation is an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. According to IPCC (2001), various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation. Successful adaptation strategies and measures result in societies that are more resilient and less vulnerable.

Adaptation actions across multiple sectors including infrastructure (e.g., building sea defence walls), individual behaviors (e.g., home level disaster preparedness), agriculture (e.g., changes in farming practices), and policy (e.g., changes in building regulations) (Matthews & Waterman, 2010). A closer examination of the IPCC report can help clarify which adaptation options are most consistent with Environmental Education. Intergovernmental Panel on Climate Change lists three general categories of adaptation options: physical and structural (this category is further divided into engineering/built environment, technological, ecosystem-based, and service), social, and

institutional. Within each of these major categories are strategies consistent with environmental values.

Within the physical/structural category, ecosystem-based adaptation is defined as the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people and communities adapt to the negative effects of climate change at local, national, regional and global levels (UNEP). It includes practices such as restoring and maintaining wetlands, mangrove swamps, and salt marshes to buffer against sea level rise and storm impacts, while also providing carbon sequestration and biodiversity benefits such as fish habitat (IPCC, 2014). In cities, green infrastructure, including green roofs, porous pavement, and parks and community gardens, can reduce climate-related flood risk and high temperatures has collateral benefits such as food production, recreation, and education.

In order to facilitate making rational ultimate decisions and choices, it is important to incorporate aspects such as the implementation of additional climate projections focusing on the target regions; the consideration and presentation of a variety of options, including phased implementation and other options; careful examination of risk-reduction effectiveness and costs; and flexible arrangements that permit reviews and changes during planning and implementation. Examples are one, improvements of river and sea embankments, and functional improvements of existing facilities. Two, land-use regulations and incentives in affected areas. Three, construction (nesting) of ecosystem networks. Four, strengthening of measures to prevent outbreaks of infectious diseases. Five, development of global food supply-and-demand systems that consider climate change impacts (30- to 50-year time frame)

based on existing projection methods. Six, the introduction of heat-resistant crop varieties and promotion of appropriate cultivation methods, to address the declining crop quality and yields. Finally, systematic water supply development to cope with recent frequent droughts.

The need for adaptation is inevitable no matter how efficiently we manage to reduce the growth in emissions (Yohe, 2000), because the inertia in the climate system will lead to climate change and resulting impacts on natural and managed systems. Measures cover a correspondingly broad range, from direct interventions such as dike building to prevent flooding, large-scale relocation of farmers, new crop selection and building of dams to expand irrigation, to capacity development in public administration, civil society, and research. There are particular concerns within the agricultural sector, and it is believed that adaptation in developed countries with temperate climates will not only reduce vulnerability but be able to realise opportunities and strengthen production (Smit & Skinner, 2002; Wheaton & Maciver 1999), as there will be reduced cold weather risks.

In developing countries, climate variability and change will enhance heat and moisture stresses and contribute to an already long list of existing problems (Schmidhuber & Tubiello 2007). The vulnerability of the agricultural sector in many developing countries is caused by poverty and limited economic capacities (e.g., to accumulate and sell products when prices are attractive) (Barbier et al, 2008), and the current socioeconomic and technological drivers of change in agriculture have hitherto rendered climate change 'just' another stressor of the system (Burton & Lim, 2005; Mertz et al., 2009).

Meaning of knowledge

Knowledge is the result of data preparation to arrive at thoughts, ideas, and speculations (Alexander, 2021; Dancy & Sosa, 1992; Gorman, 2002; Johnson & Golombek, 2003; Reinach & Viale, 2006). Knowledge goes beyond information, and includes awareness, understanding, interpretation and theorising as a product of information processing, in the context of a live experience based on education, higher education and scientific research. Subsequently, the connection between information and knowledge is persuasive, since the acquisition of knowledge depends and is predicated on the examination, application, and preparing of information. Thus, data is delivered within the setting of information direction, mindfulness, and thoughts in a specific region.

Knowledge classification

According to Gorman (2002) and Johnson and Golombek (2003), customarily, knowledge has been ordered into four classes:

1. 'The knowledge on what' alludes to the information on realities; this is frequently a sort of information that will be encoded, moved, and contained in different blends of data.
2. 'The knowledge on why' alludes to the standards and laws of nature, society, and thus the human brain.
3. 'The knowledge on how' alludes to the innate abilities and comprehension of the best approach to play out a chosen work or make something. Albeit this sort of knowledge is not unequivocal during a particular significance for simply actual limits, by and large, it shows a

capacity to realise the best approach to deliver something or do a specific work.

4. 'The knowledge of who' refers to the knowledge of who knows what, and it also means knowing an individual's ability to grasp initial knowledge and appropriate expertise to solve a specific problem.

What is essential to note here is that, aside the four customary order of information raised by (Gorman, 2002; Johnson & Golombek, 2003). There is the fifth one which these scholars refused to talk about known as 'the knowledge on where' which refers to the source or area of the data.

Alexander (2021), Dancy and Sosa (1992) and Reinach and Viale (2006) classified knowledge into explicit and implicit knowledge. Explicit knowledge is the knowledge that can be embodied and coded, so that it can be learned and invested (in fields such as education, research centres and ICT development centres). This knowledge is encoded when it is registered and transferred as codes (writings or drawings) or when it is embodied in physical forms (machine or device). Through coding operations, knowledge is reduced to information, which in turn can then be converted into knowledge by passing to the minds of individuals to whom an analytical symbol or framework is available. In this way, knowledge is spread across borders, either embodied in concrete forms or through electronic networks or any form of documentation.

Tacit knowledge on the other hand is a knowledge that cannot be coded or documented, but is implicit in the minds of individuals and their behavior, inherent in their technical and life expertise. Unlike explicit knowledge, it is only transferred through direct interaction, learning, training

and dealing with raw experience. This type of knowledge is often referred to as the know-how. As of its nature, the acquisition of tacit knowledge requires a long time of engaging in direct experience with the ones who possess it. This is why this type of knowledge is less prevalent and harder to transfer than explicit knowledge.

Tacit knowledge according to Dancy and Sosa (1992) and Reinach and Viale (2006), is complex and can be analysed, based on studies of knowledge, in three patterns:

a. The first pattern of tacit knowledge can be called as such, when equal to competence. It includes physical abilities and skills that refer to the individual's ability or capacity to learn how to perform or carry out a particular activity without being able to describe the knowledge used to perform the task. This knowledge pattern has an unreflective and automatic feature (knowledge of how to breathe, for example). It can be knowledge resulting from learning, training and a life experience (knowledge of how to play a musical instrument), or knowledge of how to perform a skill (swimming or riding a motorcycle). This pattern is rather the carrying out of activities that follow a set of rules which are not clearly or explicitly known to those who perform them. This applies in all life practices that require specific capacities to be performed or are carried out through activities that are difficult to describe accurately in clear details. This knowledge is difficult to transfer and learn, unless transferred through imitation and apprenticeship based on face-to-face interaction. One of the most effective training patterns is education and on-the-job training, which is learning by doing.

b. The second pattern is tacit knowledge as background knowledge of an individual or group. It can be defined as a set of cultural and biological capabilities that involve pre-theoretical assumptions. trends and consensus. This pattern constitutes cognitive pre-conditions in the process of accumulating cognitive theoretical formations. This pattern of background knowledge is gained and formed through the process of upbringing and acculturation. or rather through the individual's life and professional experience. in its broad historical sense. This is what makes background knowledge familiar to the individual. It requires self-consciousness. so as to change it or use it by transferring it to third parties or by third parties absorbing it. This pattern of tacit knowledge acquires great importance for those who work in the field of theory. production of ideas. innovation and research development.

c. The third pattern refers to tacit knowledge as implicitly-held cognitive rules. reflected in the individual's self-justified doctrines. the information he or she believes is valid or the rules employed in how he or she thinks and realises. Chomsky notes that this knowledge pattern does not appear in the form of specific meanings or skills. It is rather considered a realistic cognitive system determined to be a state of mind and builds a knowledge that cannot be explained in words or described in a whole language. It is a pattern of knowledge that is not taught but learned by the individual through life experience (Chomsky, 1986).

This pattern of tacit knowledge is close to what Kuhn (1970) called paradigm, that is, the intellectual pattern embraced and adopted by a specific scientific group in practising and producing science/knowledge. These

principles and methodologies are transferred to the new members (research students) through offered scientific products and the academic socialisation and integration among the members of the scientific group. That is the basis of the formation of schools of intellect and science. In all cases, tacit knowledge in its previous three forms is a procedural knowledge, a practical ability and a cognitive system (Reinach &Viale, 2006). It plays an important role in the development of science and modernisation of technology.

Demographic characteristics

Demographic characteristics are widely acknowledged as having a great impact on climate change knowledge. According to George (2010), demographic characteristics are personal characteristics and include information such as ethnicity, race and family size. Bell (2008) defines demographic characteristics as personal statistics on information such as gender, age, sex, education level, income level, marital status, occupation, religion, birth rate, death rate, average size of family, average age at marriage. For example, considering age, one is expected to be energetic and enthusiastic at an early age of their education. As they grow up within the organisation, their knowledge is expected to improve with their maturity up to a certain age when their energy levels go down and thus knowledge acquisition slows, this is what necessitates the establishment of a school going age (Adio, 2010).

Jackson, Marie and Jeroen (2009) define demographic characteristics as the presence of differences among members of a social unit. The senior high school teachers and students are more diverse in terms of gender, race, ethnicity, national origin and comprise people who are different and have different levels of knowledge. Greenberg (2004) also defines demographic

characteristics as the variety of differences between people in an organisation including race, gender, ethnic group, age, personality, cognitive style, tenure, organisational function, and education background.

Conceptual framework

The conceptual framework (Figure 1) that has been used in this thesis came from the researcher's construct. This was developed around the role of demographic characteristics on climate change knowledge.

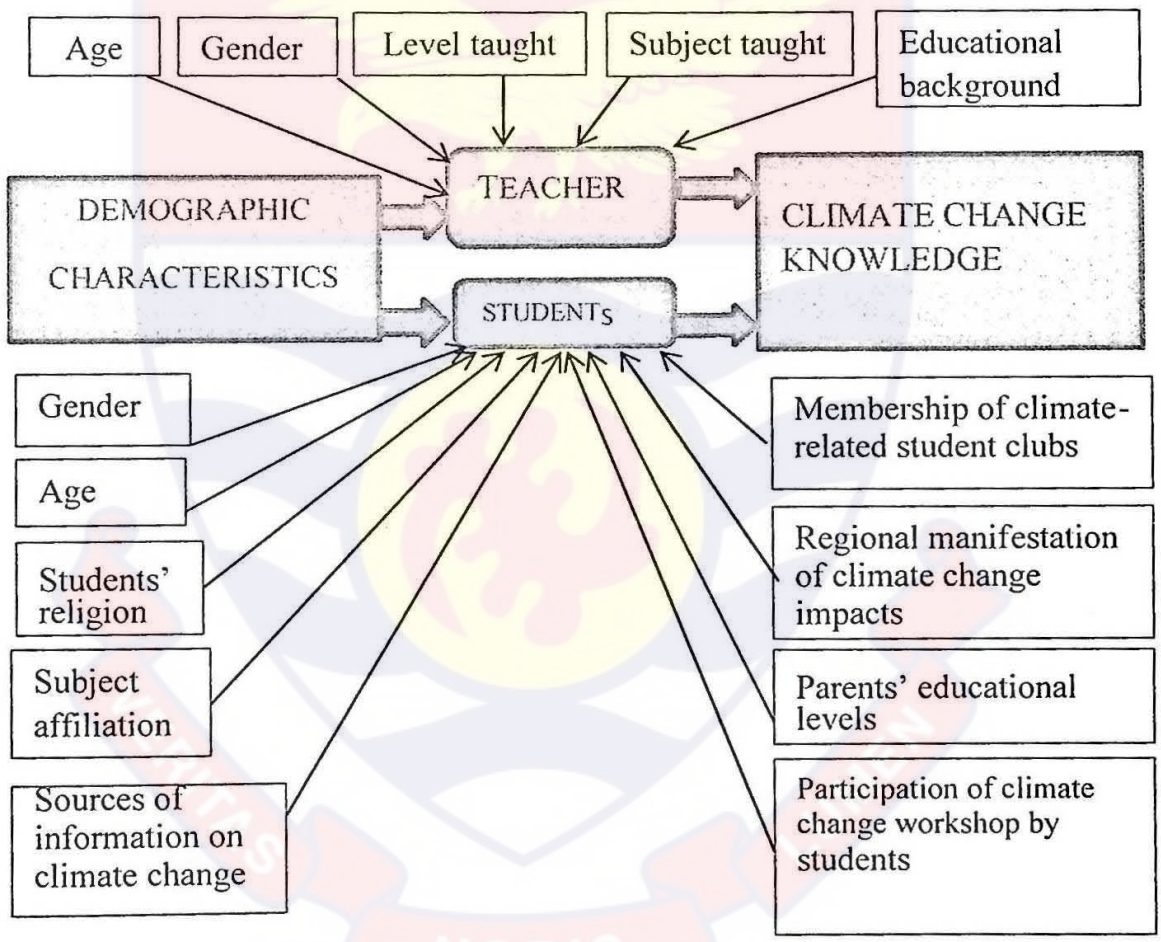

Figure 1: Role of demographic characteristics on climate change knowledge
Source: Researcher's Own Construct (2021)

Empirical Studies on Demographic Characteristics and Knowledge on Climate Change

A few investigations have led to research knowledge on climate change (Acquah, 2011; Adebayo et al., 2013; Berk & Schulman, 1995; Fortner, 2001). Nevertheless, the greater part of the investigations has centred on exact team of the populace such as third cycle scholars (Akrofi et al., 2019; Ayanlade & Jegede, 2016; Gameda & Akalu, 2015; Olajide et al., 2011; Oruonye, 2011; Spellman et al, 2003). Nothing has been done to assess senior high school teachers' and students' demographic characteristics on knowledge on climate change.

Some of the studies focused on teachers (Ekpoh & Ekpoh, 2011; Nkechi & Boakye-Yiadom, 2015; Stephen, Kibett & Obaro, 2014; Whigan, 2014), and were limited to perception. These related studies did not assess senior high school teachers' and students' demographic characteristics on knowledge on climate change.

Different investigations designated both basic and second cycle scholars (Boyes & Stanistreet, 1997; Henry et al., 2012; Kariuki, 2017; Owolabi et al., 2012), and focused on their conception and perception of climate change. None of these studies focused on the assessment of senior high school teachers' and students' demographic characteristics on knowledge on climate change.

McCright (2010) tested some theoretical arguments about gender differences in scientific knowledge and environmental concern using eight years of Gallup data on climate change knowledge and concern in the United States general public. Contrary to expectations from scientific

literacy research, women convey greater assessed scientific knowledge of climate change than men. Consistent with much existing sociology of science research, women underestimate their climate change knowledge more than men. Also, women express slightly greater concern about climate change than men, and this gender divide is not accounted for by differences in key values and beliefs or in the social roles that men and women differentially perform in society.

In Germany and the United Kingdom (UK), women were found to be more concerned about climate change than men (Shi & Pass, 2016). Women generally consider climate change to be a greater threat than men do (Carlton & Jacobson, 2013; Smith & Leiserowitz, 2012). An investigation on a study on indigenous people in Bangladesh found higher environmental awareness among women than men (Haq, 2013). However, these findings from Germany, United Kingdom, and Bangladesh are not convincing because they are suggesting that the fact that one is a man means that one would not know that it used to rain frequently for the past thirty years but now it has changed. These findings need more investigations from the research field, hence the urge to conduct this study.

Religious inclination can also be linked to knowledge on climate change (Carr et al., 2012); a recent study in a flood-affected area of Bangladesh concluded or found that Hindus tended to see climate change as human-induced, while Muslims interpreted climate change as wrought by God in response to human sin (Shah et al., 2019), while a study in Swaziland found that choices people make to adapt to climate change are linked to their membership in a social group, e.g. a religious group or a voluntary

organisation (Maswati et al., 2020). These findings by the Hindus and Muslims in relation to climate change knowledge are true because the findings were informed by their doctrines. The question is, 'what do the members of the other religious bodies say?', hence, there is the need to seek out from the residents of Cape Coast.

Gupta and Narendra (2015) conducted a study for determining demographic and psychological characteristics of environmentally concerned consumers. A cross tab analysis along with chi-square test of independence or association was applied by using the statistics Cramer's V to measure the degree of association. Furthermore, profile of concerned consumers was obtained using proportional analysis. The findings suggest that the psychological variables according to which environmental concern significantly progress include: littering concern, pollution concern, perceived consumer effectiveness against pollution, and civic sense. The significant demographic variables identified comprise: age, education, academic orientation and economic status. Conclusion was that females, elders, rural residents, better educated, academic achievers, business academics, the occupational class, respondents from large sized and high status families, with high civic sense, littering concern, pollution concern and those who perceive that their own efforts can contribute to minimise pollution problems exhibit greater levels of environmental concern than their counterparts.

Njoku (2016) examined the degree to which junior secondary school students in Port Harcourt Local Government Area of Rivers State, Nigeria, are aware of issues related to climate change and sustainable development.

The study adopted a descriptive survey design. Four research questions were raised. Two instruments were used for data collection, a questionnaire and the junior secondary school teaching syllabus. The questionnaire titled 'Climate change and Sustainable Development Awareness Questionnaire' (CCSDA) was used to obtain data from 1600 junior secondary school three (JSS3) students from the fourteen junior secondary schools in Port Harcourt Local Government of Rivers State, Nigeria. The questionnaire had three sections; A, B and C. Section A obtained the demographic features and bio-data of students, section B obtained information on the awareness level of climate change while section C obtained information on sustainable development awareness level. Simple percentages and mean were used to answer the research questions. The results from the data analysis revealed among other things that the climate change issues awareness level is high but the knowledge is low; students were eager and willing to know more about climate change issues. This finding on students must be investigated to verify or refute.

Awusi and Asare (2016) conducted a study in the Birim Central Municipality in Ghana, and 400 senior high students were randomly selected from five schools. Both closed and open-ended questionnaire was used to assess students' knowledge on climate and their participation in climate change awareness creation. The results revealed that, despite the flourishing media environment, senior high students in Birim Central Municipal have low climate change knowledge level. Also, there was no statistically significant difference in the level of climate change knowledge with respect to gender, age and the main source of information about climate change.

Again, it was found that senior high school students' involvement in climate change awareness creation is low, and there is a positive relationship between students' knowledge level and awareness creation.

Anne (2016) investigated teachers' understanding of climate change and an explanatory sequential mixed methods research design was used to examine teachers' understanding of climate change. Phase one collected survey data from over 300 Queensland primary and secondary teachers where these pieces of information were analysed to identify their understanding of climate change. Phase two collected in-depth qualitative data through semi structured interviews with 21 teachers from across Queensland. Interview data were analysed thematically and built upon data collected in phase one to present a more detailed understanding of the study. She reported that teacher's age, gender, subject taught and year level taught have influence on climate change knowledge of teachers. It is true that the longer you have lived the better your observation or the better to know what happen but weather elements take 30 years on average to comprise climate. How many respondents are 60 years and over who have experienced climate change? There is the necessity to research.

Falaye and Okwilagwe (2016) examined the knowledge, attitude and practices of 1,103 senior school students on climate change, and its related issues. The study also determined the influence of students' age, gender, religion, subject affiliation, and parents' education levels on students' knowledge. A questionnaire was employed to collect data; descriptive and inferential statistics were used for data analyses. Findings indicated that knowledge of climatic change issues is slightly low among students. Apart

from gender, all other independent variables significantly differentiate students' knowledge. Therefore, teachers need to be sensitised on the level of students' knowledge that are related to climate change and be adequately prepared to update students' knowledge of climatic issues. Parents' educational levels do not necessarily tell unless one has learnt the content in climate change. This finding cannot be accepted until it has been investigated from the field.

Suyatna and Rosidin (2017) aimed to investigate teachers and students' knowledge about global warming. The data was retrieved through objective tests on 230 teachers and 573 junior and senior high school students in Lampung Province as one of the most potential black smoke disaster areas in Indonesia. Data were collected and analysed using two Way ANOVA and Tukey multiple comparison to understand the relationship of global warming knowledge towards gender, teachers' identity, and students' educational level. The results showed that students and teachers' knowledge about global warming are very low. The students' knowledge is higher than the teachers. For students, it was found that an educational level holds the important factors of students' global warming knowledge, in which secondary school students have better knowledge and experiences relative to the primary students. There is no difference in students' knowledge of global warming caused by gender. The conclusion is that there is a difference in students' knowledge about global warming caused by differences in the learning experience but not by gender. There was no difference in knowledge between the teachers caused by subject taught, gender, or level they teach. Students who are more mature and have better

knowledge about global warming would have a disagreement on the behavior that led to the increasing greenhouse gases and are willing to sacrifice pleasures.

Akrofi, Antwi, and Gumbo (2019) analysed how the regional manifestations of climate change effects and students' involvement in various climate-related clubs and activities influenced their knowledge and awareness of climate change. Key knowledge gaps and their implications for climate action were also examined. A cross-sectional survey was adopted for the study whilst a snowball sampling technique was used to select the respondents. A total of 300 students from 26 African countries participated in the survey. Descriptive statistics, relative importance index (RII) method and the chi-square test of independence were used to analyse the data. Results showed that regional manifestations of climate change effects and students' involvement in climate change-related workshops and campaigns significantly influence their knowledge levels whilst their membership of climate-related student clubs had no significant influence. Key knowledge gaps with regards to how factors such as meat consumption and waste generation could lead to climate change were also identified. Students were also less knowledgeable about how climate change affects key issues such as conflicts, gender inequalities and job insecurity. Intensification of climate change education beyond the most common causes and effects is highly recommended among the youth. Various environment-related student clubs are also encouraged to tailor their activities in this direction.

Yang et al. (2020) made an in-depth examination of the distribution of climate change knowledge among different demographic groups. Guided

by information deficit model and cognitive miser model, two types of knowledge were investigated, including actual knowledge and illusory knowledge. Using a nationally representative survey in Singapore, this study found demographic effects in climate change knowledge distribution. Specifically, a series of independent sample t-test revealed that the males had more actual knowledge of climate change than the females. The middle aged and elderly adults had less actual knowledge but more illusory knowledge of climate change than the young adults. Compare to the more educated people, the less educated people had more illusory knowledge but less actual knowledge of climate change. People from low-income households reported lower levels of actual knowledge but higher levels of illusory knowledge than those from high-income households. There is therefore the necessity to research these findings to either to confirm or refute.

Garcia-Venuesa and Benavides (2020) researched environmental education and science teaching and identified differences in men's and women's knowledge of scientific and environmental topics. Men declared having greater knowledge, while women perceived greater risk in events involving hazards. That study explored these premises through a case study of a group of students in Mexico (N= 300) and in Spain (N= 300), ages 15-18. The students answered closed-ended questions about their knowledge and the risks of climate change. The results did not permit the establishment of a causal relationship between gender and knowledge, although they revealed that gender, as a social and cultural construction, influences the acquisition of certain knowledge.

The impacts of climate change are global, but small islands are among the most vulnerable places. Local populations on small islands might have a ground-based perspective of the impacts that threaten them. Benedicto-Royuela et al. (2020) conducted a study on Corvo (Azores), where 34% of the residents of both genders and different education levels were surveyed. Here, their understanding of climate change and their perception of its local impacts, the sense of risk, the local areas at risk, the willingness to propose mitigation and adaptation strategies, and the knowledge of regional procedures was analysed. Education played a crucial role in local understanding. The general perception was that the regional policies were insufficient to address climate change issues at the local level. This fact points out that the efforts to mitigate climate change impacts, and the public participation procedures for supporting policy-making, must be significantly increased and improved, in order to reach a real impact on local island communities.

Chapter Summary

This chapter has reviewed the Social Reconstruction theory and the Constructivist theory of learning. Various definitions of climate and climate change have been reviewed. The causes of climate change have also been reviewed. A number of these causes of climate change worth noting are: excess CO_2 within the atmosphere, chlorofluorocarbons (CFCs), depletion of the ozonosphere, combustion of energy, radiation discrepancy, marine movement (waves), deforestation and forest fires, urbanisation, wetting of the desert, and explosion of magma, among others.

Again, the effects of climate change were reviewed. A number of the effects are:

a. severe as well as extensive scarcities of water are experienced in broader zones, mostly within dry tropics and subtropics
b. rainfall remains impossible towards extension, for example, predicted in numerous great- latitude provinces
c. increases within the already high temperatures which have led to great dehydration loss in numerous emerging nations
d. greater polar thaw disturbing watercourse movements
e. inundation (flooding) of urban as well as physical structure owed towards the intensification of water height
e. fluctuation of inter-nation commercial charges of agricultural and fisheries products

Furthermore, mitigations of climate change were reviewed. A number of the climate change mitigations are:

1. the high demand for wind energy and sunlight
2. expansion of capacity of carbon basins like land in addition to forest
3. strengthening structures again towards branding them to be extra power proficient
4. finding refurbish power foundations such as stellar, air current, then water
5. assisting urban to improve extra maintainable conveyance like automobile mass quick travel, rechargeable automobiles
6. the utilisation of biofuels from crop wastes
7. abolishing fuel subsidies

8. a phase-out of coal emissions

9. stop digging for more fossil fuels

Adaptations of climate change were also reviewed. Some of the climate change adaptations are:

i. building river and sea defence walls

ii. domestic catastrophe readiness

iii. modifications of agribusiness activities/promotion of appropriate cultivation methods

iv. changes in building regulations

v. reestablishing and preserving marshes, shrub everglades, as well as saline everglades

vi. reinforcement of procedures toward the stoppage of occurrences of contagious infections

vii. construction of emerald slates, permeable path as well as squares, then public green grounds

viii. the institution of high temperature resilient foodstuffs multiplicities

ix. systematic water system developed to deal with recent frequent droughts.

Several studies have been conducted on knowledge on climate change. There are confirmations from these studies that numerous nations within the world have taken bold steps in investigating knowledge on climate change that will help combat climate change. This study assessed senior high school teachers' and students' demographic characteristics on knowledge on climate change to check this worldwide threat.

CHAPTER THREE

RESEARCH METHODS

Overview

This chapter focuses on the methods employed during the study. It first describes the study area, which is the Cape Coast Metropolis, then the research design, population, the sample and sampling technique. It also concentrates on the instruments that were used to collect the information, validity, and reliability of the instruments, data collection procedure, and data analysis procedure.

Study Area

The Cape Coast Metropolis is found within the Central Region of Ghana (Figure 2). According to the Ghana Statistical Service (2021), the Metropolis features a population of 189,925. The Metropolis is restricted to the south by the Gulf of Guinea, west, through the Komenda-Edina-EguafoAbrem Municipality, East, by the Abura-Asebu-Kwamankese District, then to the north by the Twifu-Hemang-Lower-Denkyira District. It occupies a neighborhood of roughly 122 square kilometers. According to Acheampong, Olawoyin and Manful (2020), the Cape Coast Metropolis enjoys the moist subhumid tropical climate. Due to its tropical location, the climate is warm throughout the year. The mean temperature is about 28°C. The Metropolis enjoys two precipitation terms. The chief term transpires from March to July. The second term occurs from September to October. The typical rainfall is 1149 mm.

According to the Cape Coast Metropolitan Education Office, the Metropolis has 11 public and three private senior high schools. The eleven

public senior high schools are Academy of Christ the King SHS, Adisadel College, Cape Coast Technical Institute, Effutu SHS, Ghana National College, Holy Child SHS, Mfantsipim SHS, Oguaa Senior High Technical School, St. Augustine's SHS, University Practice SHS and Wesley Girl's SHS. Figure 2 shows Cape Coast Metropolitan map showing the schools where participants were selected.

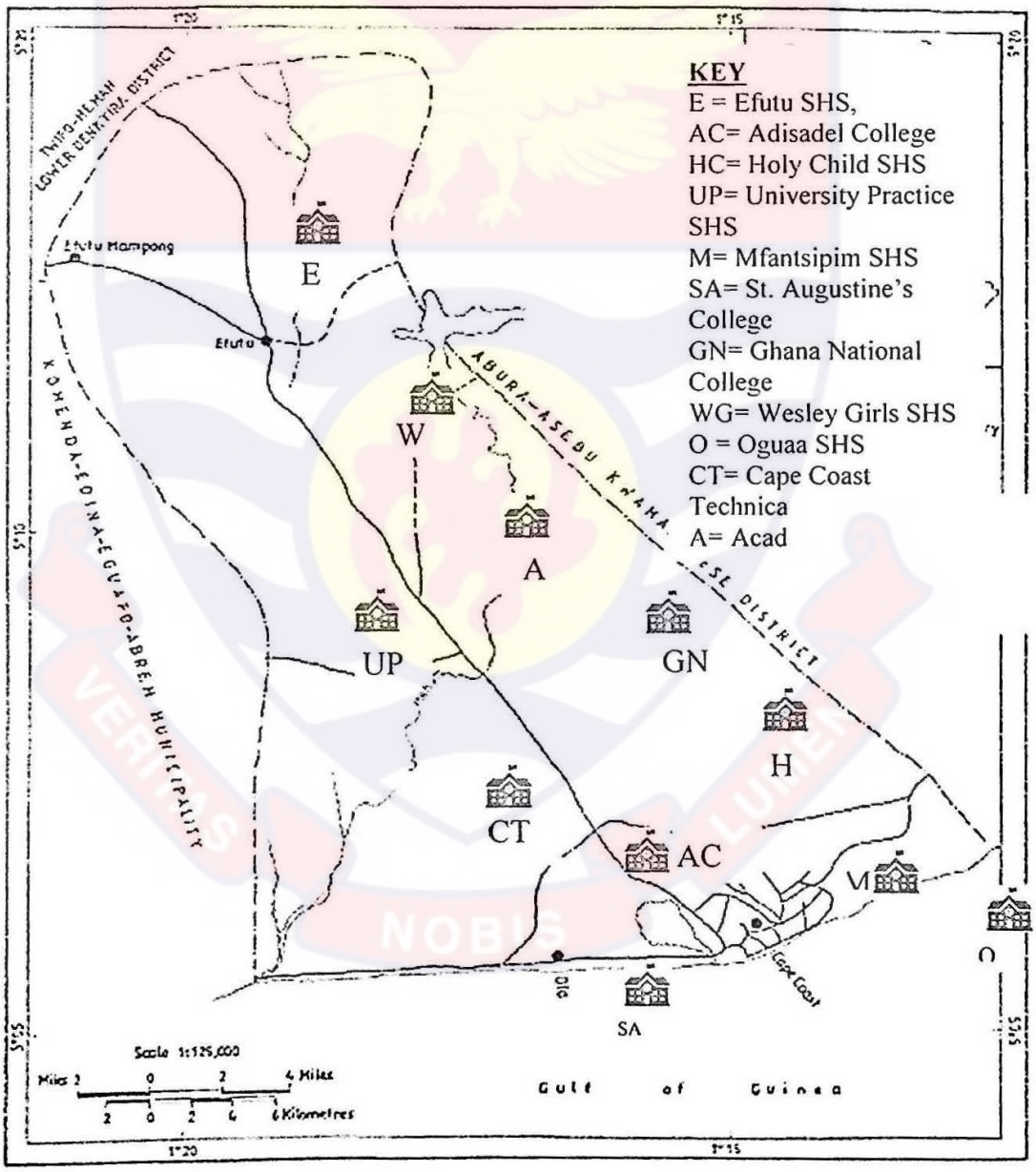

Figure 2: Cape Coast Metropolitan map showing the schools where participants were selected

Source: www.mapsofworld.com

Research Philosophy

The study adopted the positivist paradigm. According to Saunders, Lewis and Thornhill (2012), the positivist paradigm believes in the formulation of research questions and hypotheses. The positivists also believe that variables are measured on instruments and the numbered data are analysed using statistical procedures. Also, to the positivists, the researcher follows highly structured methodology in order to facilitate the research questions and hypotheses (Bryman & Bell, 2015). This presupposes that studies conducted by the positivists are based on assumptions and are free from biases. This paradigm was chosen because the study assessed the demographic characteristics of senior high school teachers and students on their climate change knowledge in the Cape Coast Metropolis.

The positivist philosophy in relation to this study is that, research questions and hypotheses were formulated. Both independent variable (demographic characteristics of senior high school teachers and students) and dependent variable (climate change knowledge) were measured on instruments (questionnaire). Again, the numbered data were analysed using statistical procedures (mean, standard deviation and factorial Anova).

The study was based on assumptions and was free from biases to the extent that hypotheses were tested and they were either confirmed or refuted. As a positivist researcher, highly structured methodology was followed in order to test the hypotheses that were formulated for the study. An important merit of this paradigm is that the researcher cannot manipulate during data collection procedure as they are independent to the subject of the research.

Research Approach

The quantitative method was utilised to obtain information on the assessment of senior high school teachers and students' demographic characteristics on their knowledge on climate change in the Cape Coast Metropolis. Both teachers' and students' questionnaires on knowledge on climate change were used to gather the relevant data for the study. The data gathered from the students and teachers were analysed using statistical tools such as means, standard deviations and factorial analysis of variance. The quantitative dataset obtained was analysed separately and the results were discussed along with the research questions and hypotheses.

Research Design

The descriptive cross-sectional survey design was adopted for this research. This design, Leedy and Omrod (2005) clarified "involves either identifying the characteristics of an observed phenomenon or exploring possible correlations among two or more phenomena. In every case, descriptive research examines a situation as it is" (p.179). A descriptive survey permits contact towards views, ideas, then, outlooks of the population of where the section of the population is derived (Gay, 1992; Gall, Gall & Borg, 2007; Shaughnessy, Zechmeister & Jeanne, 2011). During this research, the aim was to assess senior high school teachers' and students' demographic characteristics on knowledge on climate change. In order to describe the phenomenon as it is, numerical data were gathered by the use of questionnaires on senior high school teachers and students' demographic characteristics on knowledge on climate change.

The purpose of using the descriptive cross-sectional survey design was to use responses obtained from the questionnaire to provide analysis of the research questions asked and the hypotheses formulated. Another major reason for using this design was that it offered the researcher the opportunity to collect a wide scope of information from a large population. It was also used because of its usefulness in assessing demographic characteristics of the population in relation to knowledge on climate change (Babbie, 2007). The results from this current study not only gave an indication of the magnitude of the problem at a particular point in time, but also provided a basis for proposing appropriate measures to deal with the problem.

One important advantage of the descriptive cross-sectional survey was that in general, it was relatively fast and less expensive. This is because there was no need for a follow up, so fewer resources (books, funds, pens) were required to conduct the study. On the other hand, it did not provide opportunity for respondents to answer questions thoroughly across the various public senior high schools in the Cape Coast Metropolis.

Population

The target population for the research comprised teachers and students of government senior high schools within the Cape Coast Metropolis throughout the 2020/2021 academic year. In all, there were 1,177 teachers and 10,205 final year students in 11 government senior high schools in the Cape Coast Metropolis. Senior high school teachers were the population for the study for the reason being, the significant roles the teachers perform in the implementation of the senior high school curriculum. The final year students were considered in the study because they have gone

through the senior high school curriculum for a relatively longer period as compared to the first and second year students. The reason for considering public senior high schools was that the same teachers who teach at the public senior high schools do their part-time teaching at the private senior high schools. Teachers and final year students from the eleven public senior high schools in the Cape Coast Metropolis formed the accessible population for this research. The population of teachers and the students are illustrated in Table 1.

Table 1 - *Population of Teachers and Students*

School	Number of Teachers	Number of Students
Academy of Christ the King SHS	98	738
Adisadel College	105	1164
Cape Coast Technical Institute	115	944
Effutu SHS	85	735
Ghana National College	150	1342
Holy Child SHS	84	742
Mfantsipim SHS	147	1402
Oguaa Senior High Technical School	81	577
St. Augustine's SHS	102	952
University Practice SHS	115	907
Wesley Girl's SHS	95	702
Total	1,177	10,205

Source: Cape Coast Metropolis Education Office (2021)

Sample and Sampling Procedure

In describing the sample size that aimed at this research, the schedule in lieu of defining sample size as of a particular population advocated by Krejcie and Morgan (as cited in Sarantakos, 1997, p. 163) remained utilised. Krejcie and Morgan table specifies the populations and the corresponding sample sizes to be chosen. The total of teachers who participated in this research depended on the total of senior high school teachers in each school. Here, 289 teachers out of the 1,177 were selected for the study. This may perhaps aid to extend the illustrativeness of a section of the population for onward generalisation.

Senior high school teachers remained carefully chosen by means of the simple random selection procedure. "This type of sampling gives all units of the target population an equal chance of being selected" (Sarantakos, 1997, p.141). The proportion of the population members were carefully selected by using the table of random numbers. "This method is more convenient and less time-consuming....." (Sarantakos, 1997, p. 142). The teachers' attendance book served as the sample frame during the usage of the table of random numbers. Thus, each teacher in the accessible population was given a unique number. Through the utilisation of the table of random numbers, respondents were selected. The letter of the alphabet (S) was drawn across the numbers on the table of random numbers. Any teacher whose number was crossed by the letter of the alphabet (S) was chosen to serve as a respondent.

The student population of 10,205 was too large for the researcher to attempt to survey. In that case, the sample size was used to select final year

senior high school students from the 11 schools in the Cape Coast Metropolis. In describing the sample size aimed at this research, the same procedure for selecting the teachers was repeated for the students. Here, 371 students out of the 10,205 were selected for the study. This may possibly aid to extend the illustrativeness of the portion of the population for onward generalisation. The sample of teachers and students selected are demonstrated in Table 2.

Table 2- *Sample of Teachers and Students Selected*

School	Teachers Sample Size	Students Sample Size
Academy of Christ the King SHS	24	27
Adisadel College	26	42
Cape Coast Technical Institute	28	34
Effutu SHS	21	27
Ghana National College	37	49
Holy Child SHS	21	27
Mfantsipim SHS	36	51
Oguaa Senior High Technical School	20	21
St. Augustine's SHS	25	35
University Practice SHS	28	33
Wesley Girl's SHS	23	25
Total	289	371

Source: Cape Coast Metropolis Education Office (2021)

Data Collection Instruments

The data collection instruments were developed for the study. These are Teachers' questionnaire on knowledge of climate change (Tqkcc) and Students' questionnaire on knowledge of climate change (Sqkcc).

Teachers' questionnaire on knowledge of climate change (Tqkcc)

To obtain information on teachers' demographic characteristics on climate change knowledge, a multidimensional questionnaire was prepared. The instrument has a mixture of both closed and open-ended items and was divided into Sections A and B.

Section A contains items that required teachers to provide demographic information about their gender, age, highest educational qualification, subject taught, level taught, and income level. The items contained in Section A were developed based on review of empirical studies on teachers' knowledge on climate change.

Section B of Tqkcc is in four parts. The first part has 10 items, where teachers were to indicate their knowledge on the causes of climate change. The development of bits and pieces of the first part of the questionnaire was constructed on the review of literature on the causes of climate change.

The second part of Section B has six items and requires the teachers to indicate their knowledge on the effects of climate change. The items of the questionnaire were developed based on the literature reviewed on climate change impacts.

The third portion of Section B contains nine statements that sought information on teachers' knowledge on mitigation of climate change. The

bits and pieces of the questionnaire were developed based on the literature reviewed on climate change mitigations.

The fourth part of Section B are the statements on adaptations of climate change. There were nine items in this section. The development of the items was built on the review of literature on the adaptations of climate change. Teachers were required to tick on a Likert-type scale of 1-4, their responses on the four parts of Section B.

Students' questionnaire on knowledge of climate change (Sqkcc)

To obtain information on students' demographic characteristics on climate change knowledge, a multidimensional questionnaire was developed. The instrument has a mixture of both closed and open-ended items and has Sections A and B.

Section A of the Sqkcc contains items that required students to provide demographic information about their gender, age, the programme of study, religion, mother's educational level, father's educational level, climate change workshops, affiliation of environment-related student association, the regional manifestation of climate change impacts, and household income.

Section B of Sqkcc has four parts. The first part has 10 items about which students were to indicate their understanding of the causes of climate change. The development of bits and pieces of the first part of the questionnaire was based on the review of the literature on the causes of climate change.

The second part of section B has six items and required the students to indicate their understanding of the effects of climate change. The bits and

pieces were developed based on the literature review on climate change impacts.

The third portion of section B contains nine statements that sought for information on students' knowledge on the mitigation of climate change. The items were developed based on the literature review on climate change mitigations.

The fourth part of section B are the statements on the adaptations of climate change. There were nine bits and pieces of this section. The development of the items was established on the review of literature on the adaptations of climate change. Students were required to tick on a Likert-type scale of 1-4, their responses on the four parts of Section B.

Validity and Reliability of the Instruments

The data collection instruments were subjected to validity and reliability test. The instruments were given to experts to determine their face and content validity. The suggestions given by the experts were used to effect the necessary changes to improve upon the instruments. After this, a pilot test of the instruments was organised where the questionnaires were distributed to selected teachers and students at the Aggrey Memorial SHS, Aburaman SHS, and Nyankomase SHS within the Central Region of Ghana. These schools were chosen for the pilot testing because they exhibit similar characteristics in terms of the learning environment in relation to what pertains within the Cape Coast Metropolis.

The teachers and students likewise exhibit similar features in relation to their demographic characteristics. Cronbach's Alpha was established for the items that fell under each research question. Very useful suggestions

were given by some of the teachers who completed the questionnaire. For example, some words they were finding difficult to comprehend were changed to facilitate easy understanding. The arrangements of keys to the answering of the questionnaires were changed. All these actions were taken to ensure that the instruments would be capable of collecting quality and useful data for the study. Table 3 displays the Cronbach's Alpha for the various research questions that were posed for this research.

Table 3- *Cronbach's Alpha for items that fell under the Research Questions*

Items on Research questions	Cronbach's Alpha
Senior high school teachers' level of knowledge on climate change	.860
Senior high school students' level of knowledge on climate change	.799
Cronbach's Alpha for all items	.782

Source: Field data (2021)

The Cronbach's Alpha for senior high school teachers' level of knowledge on climate change, senior high school students' level of knowledge on climate change as well as the total for all the items exceeded .700. Agreeing to De Vellis (1991), such a reliability coefficient is said to be respectable. For that reason, the data collection instruments were considered reliable and appropriate to collect the relevant data to answer the questions posed. The reliability of the instruments was determined using Statistical Package for Service Solutions (SPSS) version 22.

Ethical Consideration

A researcher is supposed to employ the most appropriate methodology in researching to guarantee the soundness as well as consistency of the findings and recommendations of the research. In an

attempt to achieve this, the researcher should not harm the participants. The following were the areas that were looked at in trying to uphold the ethics of this research:

Informed consent

The respondents were to have individual freedom. Thus, research subjects have the right to be informed about the nature and consequences of research in which they are involved. Proper respect for human freedom was ensured by giving respondents the opportunity to agree voluntarily to participate in the study. The respondents participated without physical or psychological coercion and also their agreement was based on full and open information. Their disagreement too was based on full and open information. Regarding these, senior high school teachers and students were made to append their signatures to a consent letter before the data gathering processes started.

Deception

In emphasising informed consent, social science codes of ethics uniformly oppose deception. Deliberate misrepresentation is forbidden in research. The straightforward application of this principle suggests that researchers conduct data gathering without deceiving their respondents. The respondents were made to understand that pieces of information that were gathered would be used for the purpose for which they were gathered, that is academic and not anything else.

Privacy and confidentiality

Ethics in research enforce protection to guard individuals' distinctiveness as well as people of the study areas. Confidentiality needs to

be guaranteed because of the prime protection in contradiction to undesirable experience. Altogether, individual information needs to be protected otherwise hidden, but when identified, then damages or humiliations due to unresponsive enquiry activities are observed. In the analyses, respondents were not required to give their names. The Heads of Schools and their Assistants were given copies of the instruments for their perusal. This was done to make sure that the data collection process and the information required did not infringe on both senior high school teachers' and students' rights. Also, not to create ethical problems for the schools.

After they had gone through the schedules, senior high school teachers and students signed a consent form to indicate their acceptance to offer the requisite information for the study. In order not to disrupt their lessons, teachers were made to complete their questionnaires during break-time, and special arrangements were made for the students to be engaged in the data collection after closing.

Data Collection Procedures

All COVID-19 safety and health protocols were observed during the data collection. COVID-19 safety and health protocols that were observed include the following;

1. Thermometer guns or thermal scanners were used to check the temperature of the researcher and respondents at entry points of the 11 senior high schools in the Cape Coast Metropolis.
2. The researcher and the respondents wore face masks to cover the nose and the mouth at all times.

3. The researcher and the respondents washed their hands with soap under running water or rubbed hands with alcohol-based hand sanitizer before distributing the questionnaires to the respondents and after collecting the questionnaires from the respondents.
4. The researcher and the respondents always observed social distancing of at least one meter.
5. The researcher and the respondents avoided handshaking or body contact.

To make sure of a high return rate, the instruments were administered personally by the researcher. Before data collection, copies of an ethical clearance from the Institutional Review Board, University of Cape Coast were presented to the heads of senior high schools where the study was conducted. This was done to make rapport between the researcher, teachers, and students who served as respondents for the study. A discussion was held with teachers of the various schools to agree on a convenient time to administer the instruments. Permission to administer questionnaires for research purposes was sought from the schools. Participating teachers who could find time as requested were engaged to collect the specified data. Participants completed the consent form after the aim of the study and conditions of participation has been explained to them. In all the schools that the researcher visited, the teachers who were willing to take part in the research, were assured that their responses to the items on the instruments would be treated anonymously.

Fieldwork commenced on 6th May 2021 and ended on 18th June 2021.The teachers' questionnaire that was used to gather quantitative data

was administered to teachers who teach in the public senior high schools in the Cape Coast Metropolis of the Central Region of Ghana. This was done by distributing the questionnaire to the individual teachers to complete to obtain information on their gender, age, highest educational qualification, subject taught, level taught, income level, and their knowledge on climate change.

Again, the students' questionnaire that was used to gather quantitative data was administered to the senior high school final year students in the Cape Coast Metropolis. This was done by distributing the questionnaire to the individual senior high school final year students to complete to obtain information on their gender, age, the programme of study, religion, mother's educational level, father's educational level, climate change workshops, environment-related clubs, the regional manifestation of climate change impacts, household income and knowledge on climate change.

Individual participants responses to the questionnaire lasted between 40 and 45 minutes. To ensure high completion and response rate of the questionnaire, it was ensured that teachers completed and handed them over the same day. Despite the willingness of the respondents to participate in the study, there were some concerns with the completion and return of the instruments as some of the respondents wanted to complete it in their spare time. The researcher, therefore, had to ask them to give her dates and times that were convenient for her to come for them. This procedure resulted in a return rate of 69.20% for teachers' questionnaires and 69.54% for the students' questionnaires.

Data Processing and Analysis

To address the research questions and hypotheses that were formulated to guide the study, the sort of statistics that were employed with the analysis of the data were descriptive and inferential. Data were managed with the assistance of Statistical Package for Service Solutions (version 22) software. Descriptive (mean and standard deviation) and inferential (Factorial Analysis of Variance) statistical were used for analysis. The justifications for the use of the Factorial Analysis of Variance in this study were that factorial Anova uses more than one categorical independent variable and also test the effects of these independent variables on the dependent variable.

In relation to this study, senior high school teachers and students' demographic characteristics on climate change knowledge were assessed. Thus, the factorial Anova tested the effects of more than one senior high school teachers and students' demographic characteristics (gender, age, subject taught, year level taught, educational background, subject affiliation, religion, parents' educational levels, sources of information on climate change, participation in climate change workshops, membership of environment-related student clubs and regional manifestation of climate change impacts) on their climate change knowledge. The data for students and teachers were analysed separately. The data were analysed under the research questions and the null hypotheses. Table 4 shows the summary of data processing analysis.

Table 4- *Summary of Data Processing Analysis*

Research Questions/Hypotheses	Analytical Tool
1. What knowledge level do senior high school teachers have on climate change?	Mean standard deviation
2. What knowledge level do senior high school students have on climate change?	Mean standard deviation
1. H_0: There is no statistically significant difference in the knowledge of senior high school teachers towards climate change (based on gender, age, subject taught, year level taught and educational background).	Factorial ANOVA
2. H_0: There is no statistically significant difference in the knowledge of senior high school students towards climate change (based on gender, age, subject affiliation, religion, parents' educational levels, sources of information on climate change, participation in climate change workshops, membership of environment-related student clubs and regional manifestation of climate change impacts).	Factorial ANOVA

Chapter Summary

This chapter outlined the procedures employed to conduct the study. The descriptive cross-sectional survey research design was employed. All the 11 public senior high schools participated in the study. The sample size for the students who answered the questionnaires was 371, while the teachers were 289. Both teachers' and students' questionnaires on knowledge on climate change were used to gather the relevant data for the study. The simple random sampling procedure was used to select students and teachers to serve as

respondents. The data gathered from the students and teachers were analysed using statistical tools such as means, standard deviations and factorial analysis of variance.

CHAPTER FOUR

RESULTS AND DISCUSSION

Overview

The purpose of this study was to assess senior high school teachers' and students' demographic characteristics on climate change knowledge in the Cape Coast Metropolis. This section of the study presents the results of the analyses of the data gathered in the study area. It also discusses and makes inferences from the results of the study. Results are presented in tables. The results and the discussion were done concerning the research questions and hypotheses posed for the study.

Research Question 1: What level of knowledge do senior high school teachers have on climate change?

The first research question for the study attempted to investigate the level of knowledge that senior high school teachers have on climate change. Senior high school teachers should be in the best position to determine the level of knowledge they have on climate change because of the roles that they played during the implementation process. The data was analysed using mean and standard deviation presented in Table 5.

Table 5- *Level of Knowledge of Senior High School Teachers on Climate Change*

Item	Mean	Std. Deviation
Mitigation of climate change	3.19	.72
Adaptation of climate change	3.18.	.67
Impact of climate change	3.14	.73
Causes of climate change	3.03	.72
Mean of means/Standard deviation	3.14	.71

Source: Field data (2021)

Scale: (1.0 - 1.5) = Lower (2.6 - 3.0) = High

(1.6 - 2.0) = Moderately Low (3.1 - 3.5) = Moderately High

(2.1 - 2.5) = Low (3.6 - 4.0) = Higher

On a whole, it could be noted in Table 5 that the level of knowledge of senior high school teachers on climate change was 3.14 with a standard deviation of 0.71. The mean of means indicates that the level of knowledge of senior high school teachers on climate change was moderately high. This result does not resonate with the results of Suyatna and Rosidin (2017) that teachers' knowledge about climate change is very low. It is important to emphasise that this level of knowledge among teachers on climate change may be due to subjects like social studies, geography, physics, biology, chemistry, and integrated science that expose them to the causes, impacts, mitigation, and adaptation of climate change. A look at the individual items revealed the following picture.

From Table 5, the teachers had a moderately high knowledge on climate change mitigation (M = 3.19; SD = 0.72). The value of the standard deviation shows that teachers have similar responses on climate change mitigation. This also shows that the teachers will confidently impart knowledge on how to lessen the causes of climate change to their learners. This was followed by 'climate change adaptation' (M = 3.18; SD = 0.67). This indicates that the respondents had moderately high knowledge on climate change adaptation. It can be concluded that the teachers had moderately high knowledge on the adaptation of climate change. The indication is that the teachers will be bold enough to impart climate change knowledge to their

students for them to adjust to the effects of climate change in their communities.

H_0: There is no statistically significant difference in the knowledge of senior high school teachers on climate change based on demographic characteristics

A factorial ANOVA was conducted to find out the difference in teachers' knowledge of climate change based on demographic characteristics (gender, age, subject taught, level taught, educational background). The items of climate change were transformed into a composite variable. Before the results of the table were presented, the assumption of equality of variance and normality were tested. The assumption was tested in order to help select the right analytical tool.

The results of the Mean (3.13), 5% Trimmed Mean (3.18) and the Median (3.25) are approximately the same, indicating that the data is approximately normal. Again, the value of Skewness (-1.29) and Kurtosis (2.34) are within the range of +2 and -2 indicating that the data is approximately normal.

The Tests of Between-Subjects Effects for Climate Change Knowledge was conducted. Table 6 shows the results of the analysis.

Table 6- *Tests of Between- Subjects Effects for Climate Change Knowledge*

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	38.555[a]	98	.393	1.120	.286	.521
Intercept	339.535	1	339.535	966.638	.000	.905
Gender	.254	1	.254	.724	.397	.007
Age	1.109	2	.555	1.579	.211	.030
Highest Educational Qualification	.199	2	.099	.283	.754	.006
Subject taught in your school	1.335	5	.267	.760	.581	.036
Level taught in your school	.574	2	.287	.818	.444	.016
Income level	.191	2	.096	.272	.762	.005
Gender * Age	.153	1	.153	.435	.511	.004
Gender * Highest Educational Qualification	.332	1	.332	.944	.334	.009
Gender * Subject taught in your school	1.036	5	.207	.590	.708	.028
Gender * level taught in your school	.262	2	.131	.373	.690	.007
Gender * Income level	.004	1	.004	.013	.911	.000
Qualification						
Age * Subject taught in your school	2.200	6	.367	1.044	.402	.058
Age * level taught in your school	2.479	3	.826	2.352	.077	.065
Highest Educational Qualification * Subject taught in your school	1.833	5	.367	1.044	.396	.049
Highest Educational Qualification * level taught in your school	.085	2	.043	.122	.886	.002
Highest Educational Qualification * Income level	.414	1	.414	1.179	.280	.012
Subject taught in your school * level taught in your school	6.264	10	.626	1.783	.073	.150
Subject taught in your school * Income level	.001	1	.001	.003	.953	.000
Level taught in your school * Income level	.870	2	.435	1.239	.294	.024
Gender * Age * Income level						
Gender * Highest Educational Qualification * Subject taught	.169	2	.085	.241	.786	.005

Table 6 Cont

Gender * Highest Educational Qualification * level taught in your school	.010	1	.010	.028	.868	.000
Gender * Subject taught in your school * level taught in your school Gender * Subject taught in your school * Income level	.846	6	.141	.401		
Age * Subject taught in your school * level taught in your school	3.472	3	1.157	3.295	.024	
Highest Educational Qualification * Subject taught in your school *	2.521	6	.420	1.196	.315	
Error	35.477	101	.351			
Total	2032.859	200				
Corrected Total	74.031	199				

Significant at p≤ 0.05 Source: Field data (2021)

The results of the General Linear Model (GLM) corrected model showed that there is no statistically significant effect of the demographics on teachers' knowledge towards climate change, F (98) = 1.120, p = .286, partial η2 = .521. The results indicated that there was no statistically significant effect for gender F (1) = .724, p = .397, partial η2 = .007, highest educational qualification F (2) = .283, p= .754, partial η2 = .006 and income level F (2) = .272, p = .762, partial η2 = .005. However, statistical significant interactions were found with age, subject taught and level taught in your school at F (3) = 3.295, p = .024, partial η2 = .89.

The results mean that teachers' demographic characteristics (gender, highest educational qualification, and income level) combined, had no statistically significant effect on their knowledge towards climate change. The implication is that whether a teacher is a male or female does not have

any impact on their knowledge of climate change. Whether a teacher possesses a bachelor's degree or post-graduate degree does not have any effect on their knowledge of climate change. Again, whether they have low, middle, or high income does not affect their knowledge of climate change. Looking at the three levels interaction effects, the age of the teacher, the level they teach and the subject they teach combined, significantly influence their knowledge on climate change. This implies that teachers' age alone, the level they teach alone and the subject they teach alone will not influence their knowledge on climate change. However, when the three variables are combined, they will control their knowledge on climate change. These findings are not in line with the findings of most studies (Anne, 2016; Suyatna & Rosidin, 2017; Akrofi, Antwi & Gumbo, 2019; Yang, Wei & Su, 2020) who reported that gender of teachers, teachers' educational background, and teachers' income level influence their knowledge on climate change. It appears that the teacher's age and subject taught control knowledge on climate change, nevertheless, they are statistically not significant.

Research Question 2: What level of knowledge do senior high school students have on climate change?

The second research question for the study aimed to investigate the level of knowledge that senior high school students have on climate change. Final year senior high school students should be in the best position to determine the level of knowledge they have on climate change because of the roles that they played during the implementation process. The data was

analysed using means and standard deviation, and the results are presented in Table 7.

Table 7- *Level of Knowledge of Senior High School Students on Climate Change*

Item	Mean	Std. Deviation
Adaptation of climate change	2.76	.57
Impacts of climate change	2.75	.59
Mitigation of climate change	2.70	.54
Causes of climate change	2.68	.52
Mean of means/Standard deviation	2.72	.42

Source: Field data (2021)

Scale: (1.0 - 1.5) = Lower (2.6 - 3.0) = High

(1.6 - 2.0) = Moderately Low (3.1 - 3.5) = Moderately High

(2.1 - 2.5) = Low (3.6 - 4.0) = Higher

Generally, it can be noted from Table 7 that the level of knowledge among senior high school students on climate change was high. This was evident by the mean of means score of 2.72 and standard deviation of 0.42. This result does not corroborate with the study of prior researchers (for example, Awusi & Asare, 2016; Falaye & Okwilagwe, 2016; Njoku, 2016; Suyatna & Rosidin, 2017). These studies showed that students' knowledge about climate change is very low. It is important to state that this response from the participants on climate change knowledge may be due to subjects like social studies, geography, physics, biology, chemistry, and integrated science that expose them to the causes, impacts, mitigation, and adaptation of climate change. This result is characterised within the sub-items of the climate change. For

example, from Table 7, most of the students had a high knowledge on climate change adaptation (M = 2.76; SD = 0.57). This was followed by 'Impacts of climate change' (M = 2.75; SD = 0.59). This indicates that the respondents had a high knowledge on both impacts and adaptation of climate change. This finding shows that the senior high school students will be able to adjust to the impacts of climate change in the society.

H_0: There is no statistically significant difference in the knowledge of senior high school students towards climate change based on demographic characteristics

A factorial ANOVA was conducted to find out the difference in the knowledge of climate change among students based on their demographic characteristics (gender, age, the programme of study, religion, parents' educational levels, sources of information on climate change, participation in climate change workshops, membership of environment-related student clubs and the regional manifestation of climate change impacts). The items of climate change were transformed into a composite variable. Before the results of the table were presented, the assumption of equality of variance and normality were tested. The assumption was tested in order to help select the right analytical tool.

The results of the Mean (2.72), 5% Trimmed Mean (2.72) and the Median (2.69) are approximately the same, indicating that the data is approximately normal. Again, the value of Skewness (0.26) and Kurtosis (0.19) are within the range of +2 and -2 indicating that the data is approximately normal.

The Tests of Between-Subjects Effects for Climate Change Knowledge was conducted. Table 8 shows the results of the analysis.

Table 8- *Tests of Between-Subjects Effects for Climate Change Knowledge*

Source	Df	F	Sig.	Partial Eta^2
Corrected Model	22	2.226	.002	.161
Intercept	1	364.348	.000	.587
Gender	1	1.630	.203	.006
Age	2	4.294	.015	.032
Programme of study	5	4.675	.000	.084
Religion	3	1.268	.286	.015
Mother's educational level	3	.358	.783	.004
Father's educational level	3	.726	.537	.008
Participation in climate change workshop	1	.051	.822	.000
Membership of climate change club	1	.328	.567	.001
Climate change impactation in your region of residence	1	1.436	.232	.006
Household students belong	2	.650	.523	.005
Error	42.652	256		
Total	2121.551	279		
Corrected Total	50.813	278		

**Significant at p≤ 0.05 ** Significant interaction effect at p≤ 0.05*

Source: Field data (2021)

The results of the General Linear Model (GLM) corrected model showed a statistically significant effect of the demographics on students' knowledge towards climate change, F (22) = 2.226, p = .002, partial η2 = .161. Statistical significant effects were found with age, F (256, 2) = 4.294, p = .015, partial η2 = .032, and programme of study, F (256, 5) = 46.75, p = .000, partial η2 = .084. The results indicated that there was no statistically significant effect of gender on F (256, 1) = 1.630, p = .203, partial η2 = .006, religion F (256, 3) = 1.268, p= .286, partial η2 = .015, mother's educational level F (256, 3) = .358, p = .783, partial η2 = .004, father's educational level, F (256, 3) = .726, p = .537, partial η2 = .008, participation in climate change workshop, F (256, 1) = .051, p = .822, partial η2 = .000, membership of climate change club, F (256, 1) = .328, p = .567, partial η2 = .001, climate change impact manifestation in region of residence F (256, 1) = 1.436, p =.232, partial η2 =.006 and household students belong, F (256, 2) =.650 , p=.523, partial η2 =.005 on knowledge towards climate change.

These results are not congruent with the findings of most studies (Akrofi, Antwi & Gumbo, 2019; Awusi & Asare, 2016; Falaye & Okwilagwe, 2016; McCright, 2010; Suyatna & Rosidin, 2017) who claim that gender of students, the sources of information on climate change, student's religion, age, parents' educational levels, participation in climate change workshops by students, the regional manifestation of climate change impacts and their membership of environment-related student clubs influence their knowledge on climate change.

The significant effect of age and programme of study was conducted using Post hoc Scheffe analysis. The results are presented in Table 9 and 10.

The significant effect of age and programme of study was conducted using Post hoc Scheffe analysis. The results are presented in Table 9 and 10.

Table 9- *Post Hoc Analysis for Programme of Study on Climate Change Knowledge*

(I) Programme of Study	(J) Programme of Study	Mean Std. Difference (I-J)	Sig. Error	95% Confidence Interval Lower Bound	Upper Bound
	Business general	-.0749	.09053	.984	-.3785	.2287
	science	-.2743* -	.06821	.008	-.5031	-.0456
	visual arts	.1622	.07669	.485	-.4194	.0950
	home economics	.0456	.10513	.999	-.3069	.3982
General Arts						
	agricultural science	-.3412*	.09789	.036	-.6695	-.0129
	general arts	.0749	.09053	.984	-.2287	.3785
	general science	-.1994	.10170	.573	-.5405	.1416
	visual arts	-.0873	.10756	.985	-.4480	.2734
	home economics	.1205	.12939	.972	-.3134	.5545
Business						
	agricultural science	-.2663	.12358	.463	-.6807	.1481
	general arts	.2743*	.06821	.008	.0456	.5031
	Business visual	.1994	.10170	.573	-.1416	.5405
	arts	.1121	.08960	.905	-.1884	.4126
	home economics	.3200	.11489	.175	-.0654	.7053
General Science						
	agricultural science	-.0669	.10831	.996	-.4301	.2963
	general arts	.1622	.07669	.485	-.0950	.4194
	Business general	.0873	.10756	.985	-.2734	.4480
	science home	-.1121	.08960	.905	-.4126	.1884
	economics	.2079	.12012	.701	-.1950	.6107
Visual Arts						
	agricultural science	-.1790	.11384	.780	-.5607	.2028
	general arts	-.0456	.10513	.999	-.3982	.3069
	Business general	-.1205	.12939	.972	-.5545	.3134
	science visual arts	-.3200	.11489	.175	-.7053	.0654
Home Economics		-.2079	.12012	.701	-.6107	.1950
	agricultural science	-.3868	.13465	.147	-.8384	.0647
	general arts	.3412*	.09789	.036	.0129	.6695
	Business general	.2663	.12358	.463	-.1481	.6807
Agricultural Science	science visual arts	.0669	.10831	.996	-.2963	.4301
		.1790	.11384	.780	-.2028	.5607
	home economics	.3868	.13465	.147	-.0647	.8384

*Significant at $p \leq 0.05$ Source: Field data (2021)

Table 10 –*Descriptive Data for Programme of Study on Knowledge towards Climate Change*

Programme of Study	N	Mean	Std. Deviation
General Arts	133	2.63	.40
Business	24	2.70	.47
General Science	49	2.90	.35
Visual Arts	36	2.79	.49
Home Economics	17	2.58	.46
Agricultural Science	20	2.97	.39
Mean of means/Std. deviation	279	2.72	.43

*Mean difference at p≤ 0.05 Source: Field data (2021)

From Table 9 and 10, the post hoc test revealed that there is difference between General Arts students and General Science students in terms of their knowledge on climate change. However, there is no statistically significant difference in the climate change knowledge of students in Business, Visual Arts, Home Economics and Agricultural Science students. This finding resonates with the finding of Falaye and Okwilagwe (2016) whose study shows that the programme of study influences climate change knowledge. Thus, differences exist in students' knowledge of climate change based on their programme of study. The results also indicate that the impact of the programme of study on students' knowledge on climate change depends on whether they read General Science, Agricultural Science, and General Arts. Though, Falaye and

Okwilagwe's (2016) study, did not look at the interaction effect of this characteristic on each other influencing students' knowledge. This result may be due to this reason. General Science students, Agricultural Science students, and General Arts students (geography majors) are exposed to subjects that lend themselves to climate change knowledge. It is therefore expected that students from these groups would not have the same knowledge on climate change.

From Table 10, students reading General Arts were compared to students reading Business, General Science. Home Economics, Agricultural Science, and Visual Arts in terms of their knowledge on climate change. It was found out that General Science students (M = 2.9, SD = .35, p =.008), had the highest knowledge in climate change more than agricultural science students (M = 2.9, SD = .39, p = .036). When business students were compared to the other programmes of study, it was revealed that General Arts students (M = 2.6, SD = .39, p = .008) had higher knowledge in climate change than their counterparts reading Business.

The post hoc test for age revealed that there is no significant difference between the age groups. The result is presented in Table 11.

Table 11- *Post Hoc Analysis for Age on Climate Change Knowledge*

(I)age	(J)Age	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
13 to 16 years	17 to 20 years	-.2479	.13200	.173	-.5730	.0771
17 to 20 years	above 20 years	-.2823	.16715	.242	-.6939	. 1293
above	13 to 16 years	.2479	.13200	.173	-.0771	.5730

Table11 Cont

20 years					
	above 20 years	-.0344	.10879	.951	-3023.	.2335
	13 to 16 years	.2823	.16715	.242	-.1293	.6939
	17 to 20 years	.0344	.10879	.951	-2335	. 3023

Source: Field data (2021)

Chapter Summary

Considering the knowledge level senior high school teachers have on climate change, it was revealed that teachers' knowledge on climate change is moderately high. This result does not substantiate with previous studies which claim that teachers' knowledge level on climate change is very low. The study again identified that knowledge level senior high school students have on climate change is high. This result is not in line with previous studies which showed that students' knowledge level on climate change is very low.

The study also indicated that there is no statistically significant difference of the demographics on teachers' knowledge towards climate change. These demographics are gender, subject taught, year level taught, educational qualification and income level. Statistically significant interactions were found with age, subject taught and level taught. Thus, when age, level taught and subject taught combined, these variables significantly influence teachers' knowledge on climate change.

The results showed that there was statistically significant difference in the knowledge of senior high school students towards climate change based on age and programme of study. On the other hand, there was no statistically significant difference in the knowledge of senior high school students towards climate change based on gender, religion, parents' educational

levels, sources of information on climate change, participation in climate change workshops, membership of environment-related student clubs and regional manifestation of climate change impacts.

Lastly, there is difference between General Arts students and General Science students in terms of their knowledge on climate change. However, there is no statistically significant difference in climate change knowledge of students in Business, Visual Arts, Home Economics and Agricultural Science students.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Overview

This chapter presents the summary of the study, conclusions and recommendations. The summary of the study composes of summary of the research process and key findings. Based on the key findings, implications are drawn and appropriate recommendations are provided. Also, suggestions of further studies were provided.

Summary of Research Process

The purpose of this study was to assess senior high school teachers' and students' demographic characteristics on their climate change knowledge in the Cape Coast Metropolis. The following research questions and hypotheses that were formulated guide the study.

1. What knowledge level do senior high school teachers have on climate change?
2. What knowledge level do senior high school students have on climate change?

1. H_0: There is no statistically significant difference in the knowledge of senior high school teachers on climate change based on demographic characteristics (gender, age, subject taught, level taught, and educational background).
2. H_0: There is no statistically significant difference in the knowledge of senior high school students towards climate change based on demographic characteristics (gender, age, subject affiliation, religion, parents' educational levels, sources of information on climate change, membership

of climate change workshops, affiliation of environment- related student association and the regional manifestation of climate change impacts).

To find answers to the research questions and the hypotheses that were formulated to guide the study, the descriptive survey research design was employed. All the 11 public senior high schools in the Cape Coast Metropolis participated in the study. The sample size for the students was 371 and for the teachers was 289. Questionnaires were used to gather the data for the study. The simple random sampling procedure was used to select students and teachers to serve as respondents. The questionnaires were subjected to reliability and validity test. The data gathered from the students and teachers were analysed using means, standard deviations, and factorial ANOVA. The following were the main findings of the study.

Key Findings

Generally, the study revealed that both senior high school teachers and students have high knowledge on climate change. It also indicated that some senior high school students' demographic characteristics control their knowledge on climate change whereas others do not. In addition, the study showed that senior high school teachers' demographic characteristics do not control their knowledge on climate change. The individual findings, reflecting the various research questions and hypotheses, which contributed to this overall assessment of high knowledge on climate change, some demographic characteristics controlling and others not controlling knowledge on climate change are further provided in some depth.

1. Senior high school teachers of the study area have moderately high knowledge on mitigation of climate change, the adaptation of

climate change, the impact of climate change, and the causes of climate change.

2. Senior high school students of the study area have high knowledge on mitigation of climate change, the adaptation of climate change, the impact of climate change, and the causes of climate change.
3. There was no statistically significant difference in the knowledge of climate change of teachers based on their demographic characteristics.
4. There was statistically significant difference in the knowledge of climate change of students based on their demographic characteristics. Age and programme of study statistically influence their knowledge on climate change.

Conclusions

With the high teacher knowledge on climate change issues, teachers will be able to deliver climate change issues confidently during instructional time. With high student knowledge on climate change issues, students will also have the power to lessen the causes of climate change and will be able to adjust to the impacts of climate change in their communities.

Secondly, the implication of this finding is that whether you are a male or female teacher does not determine one's knowledge on climate change. A teacher's knowledge on climate change will not depend on whether he or she is young or old. Again, a teacher's knowledge on climate change will not depend on whether he or she is teaching science or humanities subjects. Teacher's knowledge on climate change will not depend on whether he or she is teaching S.H.S. 1, 2 or 3 and whether he or she is having undergraduate

degree or postgraduate degree. Their knowledge on climate change is the same irrespective of their gender, age, subject taught, level taught and educational level.

Furthermore, a student's knowledge on climate change depends on his or her age and the programme he or she is pursuing in the school. That is to say that a matured student is able to conceptualise climate change issues more than a younger student. Moreover, General Science students are able to acquire knowledge on climate change issues more than their counterparts in other programmes of study.

Recommendations

Recommendations are made to respond to the various actions to be taken by key stakeholders in education. Based on the findings of the study and the conclusions drawn from the study, the following are some recommendations for professional practice.

1. The teachers should not relent in their knowledge on climate change. They should continue to sustain their knowledge on climate change.
2. The teachers should not be complacent with their impartation of climate change knowledge to their students. They should continue to impart climate change knowledge to their students.
3. Unit heads of the various senior high schools should assign experienced teachers to impart climate change knowledge to the Business, Visual Arts, and Home Economics students. This is because climate change knowledge depends on the programmes that students are reading in their schools.

4. Teachers must consider students' ages when delivering climate change issues during instructional period. They should slow down with young students during delivery of climate change lessons.

Policy Formulation

The use of the climate change knowledge questionnaire to assess senior high school teachers and students' demographic characteristics on climate change knowledge is an invaluable tool to provide useful information for informed policy modification. Based on the findings of the study and the conclusions drawn from the study, these are some recommendations for policy formulation.

1. During policy formulation on climate change education, the government of Ghana should not place much emphasis on teacher demographic characteristics since they do not control teachers' knowledge on climate change. In the organisation of workshop for teachers by the Ghana Education Service in order to abreast the teachers on climate change education policies, teachers should not be categorised or segregated according to their demographic characteristics. This is because their knowledge on climate change will not depend on their demographic characteristics.
2. The government of Ghana through the National Council for Curriculum and Assessment (NACCA) should innovate the senior high school Social Studies curriculum. This can be done by introducing more topics on climate change into the existing senior high school Social Studies curriculum. Eventually, Business, Visual

Arts and Home Economics senior high school students will benefit a lot from it.

Contribution to Knowledge

Previous works conducted on climate change knowledge focused on pre-tertiary and tertiary students' perception but this current study concentrated on the assessment of senior high school students' demographic characteristics on their climate change knowledge. In addition, available literature was clear on teachers' perceptions on climate change knowledge however, the present study has contributed to knowledge by coming out with the assessment of senior high school teachers' demographic characteristics on their climate change knowledge. Geographically, these earlier studies were conducted in the United States of America, Kenya and Nigeria, whereas this existing study has been conducted in the Cape Coast Metropolis in Ghana with different findings. With this, this contemporary study has contributed to knowledge by filling both literature and geographical gaps.

Furthermore, the purpose of this contemporary research was to assess senior high school teachers' and students' demographic characteristics on their climate change knowledge in the Cape Coast Metropolis. So far, most studies on climate change knowledge did not have conceptual framework. In this study, the researcher has designed one which is known as "The Role of Demographic Characteristics on Climate Change Knowledge" (see Figure 1). Also, former works did not back their studies with social reconstructionism theory and constructivist theory of learning, that notwithstanding, this present study has been able to contribute to knowledge by relating these theories to climate change knowledge.

Moreover, this current study has filled methodological gaps in terms of the research design, the sampling technique, the data collection instrument and the analytical tool. With the research design, most earlier studies employed explanatory sequential mixed methods and case study while this present study employed descriptive cross-sectional survey. Again, previous studies analysed their data with cross tab analysis, chi-square, Cramer's V, proportional analysis, percentages, Tukey multiple comparison, relative importance index, two-way ANOVA and independent sample t-test. On the other hand, this present study used mean, standard deviation and factorial analysis of variance to analyse its data from the field. So, with this, it has contributed to knowledge. Older studies have used semi-structured interviews as their data collection tool and snowball sampling technique as their sampling procedure, this current study has contributed to knowledge with the use of the questionnaire and simple random as data collection instrument and sampling procedure respectively. Deductively, the forgoing discussion shows that this current study "The Assessment of Senior High School Teachers and Students' Demographic Characteristics on their Climate Change Knowledge in the Cape Coast Metropolis" has contributed to knowledge by filling literature gap, geographical gap and methodological gap.

Suggestions for Further Research

For the benefit of future researchers, there have been some suggestions for further study. For ease of generalising the findings of this study, it is highly suggested that:

1. Similar studies be conducted in the entire country to enhance more concrete information on the assessment of demographic characteristics

on senior high school teachers' and students' knowledge on climate change.

2. Paper and pencil tests should be used to replicate the assessment of demographic characteristics on senior high school teachers' and students' knowledge on climate change.
3. A similar study should be conducted by using multivariate analysis of variances (MANOVA) to analyse senior high school teachers' and students' demographic characteristics on the causes, impact, mitigation, and adaptation of climate change.

REFERENCES

Acheampong, P. K. (2016). *The earth: Themes and variations.* Cape Coast: University Printing Press.

Acheampong, P. K., Olawoyin, R., & Manful, H. (2020). *The thematic geography of Ghana.* Cape Coast: College of Distance Education, UCC.

Acquah, H. D. (2011). Public awareness and quality of knowledge regarding climate change in Ghana: A logistic regression approach. *Journal of Sustainable Development in Africa, 13*(3), 146-157.

Adebayo, A. A., Mubi, A. M., Zemba, A. A., & Umar, A. S. (2013). Awareness of climate change impacts and adaptation in Adamawa State, Nigeria. *International Journal of Environment, Ecology, Family and Urban Studies, 3*(1), 11-18.

Adio, G. (2010). *Demographic variables and self-efficacy as factors influencing career commitment of librarians in federal university libraries in Nigeria.* (University of Ibadan, Nigeria). Retrieved from https://doi.org/10.1108/00242531011031160

Akrofi, M. M., Antwi, S. H., & Gumbo, J. R. (2019). Students in climate action: A study of some influential factors and implications of knowledge gaps in Africa. *Environment, 6*(12), 1-15.

Alexander, R. (2021). *Different types of knowledge: Implicit, tacit, and explicit.* Retrieved from https://bloomfire.com/blog/implicit-tacit-explicit-knowledge.

AllAfrica (2013). *Africa: Impact of climate change on forests requires early action*. Retrieved from http://allafrica.com/stories/201309232292.html.

Anderson, K. (2012). *Real clothes for the emperor: Facing the challenges of climate change. The Cabot annual lecture*. Bristol: University of Bristol.

Anderson, K., & Bows, A. (2011). Beyond dangerous climate change: Emission scenarios for a new world. *Philosophical Transactions of the Royal Society*. Retrieved from https://ui.adsabs.harvard.edu/abs/2011rspta.369...20a.

Anderson, K., & Bows, A. (2012). A new paradigm for climate change. *Nature of Climate Change, 2*(9), 39-40.

Anijah-Obi, F. N. (2001). *Fundamentals of environmental education and management.* Calabar: Clear Lines Publications.

Anne, N. J. (2016). *Understanding how Queensland teachers' views on climate change and climate change education shape their reported practices*. PhD thesis, James Cook University. Retrieved from http://researchonline.jcu.edu.au/48975/.

Anyon, J. (1980). Social class and hidden curriculum of work. *Journal of Education, 162*(1), 67-92.

Apple, M. (1996). *Subject guide to children's books in print*. India: R. R. Bowker LLC.

Awusi, E., & Asare, K. (2016). Climate change knowledge and awareness creation in relation to the media among senior high students in Birim Central Municipal, Ghana. *Journal of Environmental Science, Toxicology and Food Technology*, *10*(9), 83-89.

Ayanlade, A., & Jegede, M. O. (2016). Climate change education and knowledge among Nigerian university graduates. *Weather, Climate, and Society, 8*(4), 465-472.

Babbie, E. (2007). *Survey research methods* (3rd ed.). New Delhi: Prentice Hall of India Private Ltd.

Badu-Agyei, B. (2012). *Climate change impacts on Ghana, are the politicians interested?* Retrieved from http://ghananewsagency.org/features/climate-change-impacts-onghana-are-thepoliticians-interested–52641.

Bangay, C., & Blum, N. (2010). Education responses to climate change and quality: Two parts of the same agenda? *International Journal of Educational Development, 30*(4), 335-450.

Barbier, B., Yacouba, H., Karambiri, H., Zorome, M., & Some, B. (2008). Human vulnerability to climate variability in the Sahel: Farmers' adaptation strategies in northern Burkina Faso. *Environmental Management, 43*(5), 790-803.

Bast, J. L. (2013). *Seven theories of climate change*. Chicago: The Heartland

Bell, G. (2008). *Selection. The mechanism of evolution* (2nd ed). Oxford: Oxford University Press.

Benedicto-Royuela, J., Hervías-Parejo, S., Ambros, B., de la Cruz, A., & Gil, A. (2020). Assessing the local perception of climate change in a small island: A case study. *Int. J. Global Warming, 22*(1), 30–53.

Berk, R. A., & Schulman, D. (1995). Public perceptions of global warming. *Climate Change, 29*(1), 1-33.

Boadi, S. (2013, September 16). Climate change problems to affect Ghana. *Daily Guide.* Retrieved from http://ghananewsagency.org/features/climate-change-impacts-on-ghana-are-the-politiciansinterested–52641.

Boakye, C. (2015). *Climate change education: The role of tertiary science curricula in Ghana.* SAGE Open.

Boyes, E., & Stanisstreet, M. (1997). Children's models of understanding of two major global environmental issues (ozone layer and greenhouse effect). *Research in Science & Technological Education, 15*(1), 19-28.

Brameld, T. (1950). *Ends and means in education*. New York: Harper and Row, Inc.

Brameld, T. (1956). *Toward a reconstructed philosophy of education*. New York: Dryden Press. Cambridge University Press.

Bryman, A. & Bell, E. (2015). *Business research methods* (4th ed.). Oxford: Oxford University Press.

Burton, I., & Lim, B. (2005). Achieving adequate adaptation in agriculture. *Climatic Change, 70*(1), 191–200.

Cape Coast Metropolitan Map showing the Study Areas. Retrieved from http://www.mapsofworld.com.

Carlton, S. J., & Jacobson, S. K. (2013). Climate change and coastal environmental risk perceptions in Florida. *Journal of Environmental Management, 130*(2013), 32-39.

Carr, B., Gates, M. F., Mitchell, A., & Shah, R. (2012). Giving women the power to plan their families. *The Lancet, 380*(9837), 80-82.

Chan, J. C. L. (2006). Comments on changes in tropical cyclone number, duration, and intensity in a warming environment. *Science, 311*(5768), p.1713b.

Chen, S. (2006). *Researching on strategy of climate education in middle school geography instruction.* Fujian: Normal University.

Chomsky, N. (1986). *Knowledge of language: Its nature, origin and use*. New York: Praeger.

Chow, L. (2019). Di Caprio-Funded study: Staying below 1.5°C is totally possible. *Ecowatch.* Retrieved from https://www.ecowatch.com/dicaprio-climate-change-2626634576.html.

Christensen, J. H., Hewitson, B., Busuioc, A., Chen, A., Gao, X., Held, I., Jones, R., Kolli, R. K., Kwon, W.T., Laprise, R., Magan˜a Rueda, V., Mearns, L., Mene´ndez. C. G., Ra¨isa¨nen, J., Rinke, A., Sarr, A., & Whetton, P. (2007). Regional climate projections. In S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, & H. L. Miller (Eds.), *Climate change 2007: The physical science basis. Contribution of Working Group I to the fourth assessment report of the intergovernmental panel on climate change* (pp. 847–940). Cambridge: Cambridge University Press.

Climate Change Facts Sheet (2013). *Facts about climate change*. Retrieved from http://web.cerritos.edu/tstolze.

Counts, G. S. (1932a). Dare progressive education be progressive? *Progressive Education, 9*(4), 257–263.

Counts, G. S. (1932b). *Dare the school build a new social order*?. New York: John Day.

Counts, G. S. (1934). *The social foundation of education*. New York: Scribner.

Cremin, L. A. (1977). Public education. *Journal of Teacher Education, 28*(3), 60-61.

Cruz, R. V., Harasawa, H., Lal, M., Wu, S., Anokhin, Y., Punsalmaa, B., Honda, Y., Jafari, M., Li, C., & Huu Ninh, N. (2007). In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, & C. E. Hanson (Eds.), *Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the fourth assessment report of the intergovernmental panel on climate change* (pp. 469–506). Cambridge: Cambridge University Press.

Dai, A., Trenberth, K., E., & Qian, T. (2004). A global dataset of Palmer Drought Severity Index for 1870–2002: Relationship with soil moisture and effects of surface warming. *Journal of Hydrometeorology, 5*(6), 1117–1130.

Dancy, J., & Sosa, E. (Eds.). (1992). *Blackwell companion to epistemology*. Oxford: Blackwell.

De Vellis, R. F. (1991). *Scale development: Theory and applications.* Newbury Park: Corwin Press, Inc.

Ekpoh, U., & Ekpoh, I. (2011). Assessing the level of climate change awareness among secondary school teachers in Calabar Municipality, Nigeria: Implication for management effectiveness. *International Journal of Humanities and Social Science, 1*(3), 106-110.

Emanuel, K. (2005). Increasing destructiveness of tropical cyclones over the past 30 years. *Nature, 436*(7051), 686–688.

Falaye, F. V., & Okwilagwe, E. A. (2016). Assessing the senior school students' knowledge, attitude and practices related to climate change: Implications for curriculum review and teacher preparation. *JISTE, 20*(1), 43-53.

Fischer, G., F. N., Tubiello, H., Velthuizin, V. H., & Wiberg, D. A. (2007). Climate change impacts on irrigation water requirements: Effects of mitigation, 1990-2080. *Technol. Forecast. Soc. Change*, *74*(7), 1083-1107.

Forster, P., Ramaswamy, V., Artaxo P., Berntsen, T., Betts, R., Fahey, D. W., Haywood, J., Raga, G., Schulz, M., & Van Dorland, R. (2007). *Changes in atmospheric constituents and in radiative forcing in climate change*. Cambridge: Cambridge University Press.

Fortner, R. (2001). Climate change in school: Where does it fit and how ready are we? *Canadian Journal of Environmental Education, 6*(2001), 18-31.

Freire, P. (1970). *Pedagogy of the oppressed*. New York: Herder and Herder.

Freire, P. (1993). *Education for critical consciousness*. New York, NY: Continuum.

Freire, P. (1997). *Pedagogy of the heart*. New York, NY: Continuum.

Gall, M. D., Gall, J. P., & Borg, W. R. (2007). *Educational research: An introduction* (8th ed.). Toronto: Pearson Education, Inc.

Gameda, D. O., & Akalu, D. S. (2015). Climate change adaptation and mitigation: Student's knowledge and experience in Jimma University, Ethiopia. *International Journal of Sciences: Basic and Applied Research (IJSBAR), 23*(2), 123-137.

Garcia-Vinuesa, A., & Benavides, L. O. B. (2020). *Gender inequalities in education for climate change. Case study: Mexico and Spain.* Retrieved from https://www.researchgate.net/publication/344629534.

Gay, L. R. (1992). *Educational research: Competencies for analysis and application*. New York: Merrill Prentice.

George, A. (2010). *Demographic variables and self-efficacy as factors influencing career commitment of librarians in federal university libraries in Nigeria*. Ibadan: University of Ibadan.

Ghana Statistical Service (GSS). *Population and Housing Census (2021)*. Accra, Ghana: Statistical Service.

GhanaCentric (2010). *Climate change and Ghana*. Retrieved from http://inghana.wordpress.com/2010/08/31/climate-changeand-ghana/.

Giroux, H. (1992). *Border crossing*. New York: Routledge.

Giroux, H. (2005). *Border crossings: Cultural workers and the politics of education*. New York: Routledge.

Giroux, H. (2006). *Politics, culture and education*. New York: Palgrave.

Global Climate Change Vital Signs of the Planet (2020). Retrieved from https://climate.nasa.gov/.

Global Environmental Facility Investigating in Our Planet (2020). Retrieved from https://climate.nasa.gov/solutions/adaptation-mitigation/.

Gorman, M. (2002). Poverty, policy, reciprocity and older people in the South. *Journal of International Development, 14*(8), 1143-1151.

Greenberg, L. S. (2004). Special issue: Emotion. *Clinical Psychology and Psychotherapy, 11*(1), 1–2.

Greene, L. (1988). *Music on deaf ears: Musical meaning, ideology and education*. Manchester, UK: Manchester University Press.

Groisman, P. Y, Knight, R. W., Easterling, D. R., Karl, T. R., Hegerl, G. C., & Razuvaev, V. N. (2005). Trends in intense precipitation in the climate record. *Journal of Climate, 18*(9), 1326–1350.

Gupta, K., & Narendra, S. (2015). Profiling environmentally concerned consumers in India: An empirical analysis. *Indian Management Studies Journal, 19*(2). 167- 192.

Haq, F. (2013). The profile and activity of citizen journalists: A study on Bangla blog community. In B. Shoesmith, & J. W. Genilo (Eds.), *Bangladesh's changing mediascape: From state control to market forces* (pp. 259-276). Bangladesh: Intellect Publisher.

Harvey, F. (2019, November 26). UN calls for push to cut greenhouse gas levels to avoid climate chaos. *The Guardian*. Retrieved from https://www.theguardian.com/environment/2019/nov/united-nationsglobal-effort-cut-emission-stop-climate-chaos-2030.

Henry, O., Emmanuel, K., & Mark, O. (2012). Assessment of junior high school students' awareness of climate change and sustainable development in Central region, Ghana. *Educational Research Journal, 2*(9), 308-317.

Houghton, J. (2004). *Global warming, the complete briefing* (3rd ed.). Cambridge: Cambridge University Press.

International Renewable Energy Agency [IRENA] (2017). *Renewable energy in district heating and cooling: A sector roadmap for remap*. Abu Dhabi: International Renewable Energy Agency (IRENA).

Investopedia Staff (2019). *Demographics*. Retrieved from https://www.investopedia.com/terms/d/demographics.asp.

IPCC (2001). *Summary for policymakers to climate change 2001: Synthesis of the ipcc third assessment report*. London: IPCC.

IPCC Fourth Assessment Report (2007a). *A blanket around the earth*. Retrieved from http://www.ipcc.ch/pdf/assessmentreport/ar4/syr.

IPCC Fifth Assessment Report (2014). *Mitigation of climate change*. Retrieved from http://www.ipcc.ch/pdf/assessmentreport/ar4/syr.

Issues in Science (2013). *Promoting low-carbon electricity production.* Retrieved from http://www.issues.org/23.3/apt.html.

Jackson, R., Marie, B. S., & Jeroen, G. (2009). *Critical terrorism studies: A new research agenda*. New York: Routledge.

Johnson, K. E., & Golombek, P. R. (2003). Seeing teacher learning. *JSTOR, 37*(4), 729-739.

Joseph, B., Bravmann, S. P. L., Windschitl, M. A., Mikel, E. R., & Green, N. S. (2000). *Cultures of curriculum.* Mahwah, NJ: Lawrence Erlbaum Associates.

Kariuki, C. N. (2017). Curriculum and its contribution to awareness of climate change among learners in secondary schools in Githunguri subcounty, Kiambu county, Kenya. (Master's thesis, Kenyatta University). Retrieved from file:///C:/Users/user/Downloads/Kariuku,%202017.pdf.

Kuhn, T. S. (1970). *The structure of scientific revolutions* (2nd ed.). Chicago, London: University of Chicago Press Ltd.

Kunateh, M. A. (2013, September 24). Climate change threatens Ghana's food security. *The Chronicle.* Retrieved from http://thechronicle.com.gh/climatechangethreatensghana%E2%80%99s-food-security.

Leedy, P. D., & Ormrod, J. E. (2005). *Practical research: Planning and design* (8th ed.). Upper Saddle River, New Jersey: Merril/Prentice Hall.

Magrin, G., Garcia, C. G., Choque, D. C., Gime´nez, J. C., Moreno, A. R., Nagy, G. J., Nobre, C., & Villamizar, A. (2007). Latin America. In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, & C. E. Hanson (Eds.), *Climate change 2007: Impacts, adaptation and vulnerability, contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change* (pp. 581-615). Cambridge, UK: Cambridge University Press.

Maswati, S. S., Mduduzi, C. S., Kerry, V., & Eugene, Z. (2020). Determinants of households' access to improved drinking water sources: A secondary analysis of Eswatini 2010 and 2014 multiple indicator cluster surveys. *Advances in Public Health, 2020*(2020), 1-9.

Matthews, J., & Waterman, P. (2010). Sustainable literacy and climate change: Engagement, partnerships, projects. In W. L. Filho (Ed.) *Universities and climate change: Introducing climate change to university programmes* (83-88). Heidelberg: Springer.

McCright, A. M. (2010). The effects of gender on climate change knowledge and concern in the American public. *Popul. Environ., 32*(1), 66–87.

McEachron, G. A. (2001). *Self in the world: Elementary and middle school social studies*. Dubuque: McGraw-Hill.

McLaren, P. (2007). *Life in school: An introduction to critical pedagogy in the foundations of education.* Boston: Pearson.

McLaren, P., & Giroux, H. (1997). Writing from the margins: Geographies of identity, pedagogy and power. In P. McLaren (Ed.), *Revolutionary multiculturalism: Pedagogies of dissent and for the new millennium* (pp. 16-41). Boulder, CO: Westview Press.

McLeod, S. (2019). *Constructivism as a theory for teaching and learning*. Simply Psychology. Retrieved from www.simplypsychology.org/constructivism.html

Mertz, O., Mbow, C., Reenberg, A., & Diouf, A. (2009). Farmers' perceptions of climate change and agricultural adaptation strategies in rural Sahel. *Environmental Management, 43*(5), 804 – 816.

Müller-Kuckelberg, K. (2012). *Climate change and its impact on the livelihood of farmers and agricultural workers in Ghana.* Retrieved from http://www.fessustainability.org/sites/default/files/u43/fes_presurvey_climatechange_farmers_complete_final2012.pdf.

National Aeronautics and Space Administration [NASA] (2005). *What's the difference between weather and climate?* Retrieved from http://www.nasa.gov/mission_pages/noaa-n/climate.

National Research Council [NRC] (2010a). *Informing an effective response to climate change.* Washington DC: The National Academies Press.

Nicole, L. (2012). *An overview and the causes of global warming*. Retrieved from http://geography.about.com/od/globalproblems.

Njoku, C. (2016). Awareness of climate change and sustainable development issues among Junior Secondary School (JSS) students in Port Harcourt Metropolis, Nigeria. *International Journal of Curriculum and Instruction, 8*(2), 29–40.

Nkechi, S. O., & Boakye-Yiadom, L. (2014). The gender dimension of the effects of land tenure security on agricultural productivity: Some evidence from two districts in Kenya. *Journal of International Development, 27*(7), 917-928.

Nordhaus, W. D. (2010, June). Economic aspects of global warming in a post-Copenhagen environment. *PNAS, 107*(26), 11721–11726.

Obeng, E. A. (2012). Curriculum response to climate change and development. In I. O. Oloyede (Ed.), *Climate change and sustainable development in Africa* (pp. 3-12). *Proceedings of the Second University of Cape Coast and University of Ilorin Joint International Conference*. Ilorin, Nigeria: University of Ilorin Press.

Ofei-Nkansah, K. (2013). *Promoting rights in the fight against climate change*. Retrieved from http://library.fes.de/pdf-files/bueros/ghana/10516.pdf.

Olajide, F. O., Owolabi, O. A., Olajide, A. O., Oospore, A. G., Unlade, A. O., & Omobuwa, O. (2011). Knowledge about the causes, consequences and control of global warming among undergraduates of Obafemi Awolowo University, Ile Ife (pp. 248-261). In A. T. Salami, & O. O. I. Orimoogunje (Eds.) *Environmental research and challenge of sustainable development in Nigeria*. Ile Ife: OAU Press.

One Earth Climate Model (2020). University of Technology, Climate and Energy College, German Aerospace Center. Retrieved from https://oneearth.uts.edu.au.

Oppenheimer, M., M., Campos, R., Warren, J., Birkmann, G., Luber, B. O., & Takahashi, K. (2014). Emergent risks and key vulnerabilities. In *IPCC AR5 WG2 A 2014* (p.52). Retrieved from file:///c:/users/user/desktop/climatechangemitigation-wikipedia.

Oruonye, E. D. (2011). An assessment of the level of awareness of the effects of climate change among students of tertiary institutions in Jalingo Metropolis, Taraba State Nigeria. *Journal of Geography and Regional Planning. 4*(9), 513-517.

Osbergh, K. M. (1997). *Constructivism in practice. The case of meaning - making in the virtual world.* Unpublished doctoral thesis, University of New York, New York.

Ouyang, X., & Lin, B. (2017). Carbon dioxide emissions during urbanisation: A comparative study between China and Japan. *Journal of Cleaner Production. 143*(2017), 356-368.

Owolabi, H. O., Gyimah, E. K., & Amponsah, M. O. (2012). Assessment of junior high school students' awareness of climate change and sustainable development in Central region, Ghana. *Educational Research Journal, 2*(9). 308-317.

Postman, N., & Weigartner, C. (1969). *Teaching as a subversive activity.* New York: Delacorte Press.

Reinach, S., & Viale, A. (2006). Application of a human error framework to conduct train accident/incident investigations. *Accident Analysis and Prevention, 38*(2006), 396–406.

Rogner, H. H., Zhou, D., Bradley, R., Crabbe, P., & Edenhofer, O. D. (2007). Intensities. Introduction. In B. Metz, O. R. Davidson, P. R. Bosch, R. Dave, & L. A. Meyer (Eds.), *Climate change 2007: Mitigation. Contribution of working group III to the fourth assessment report of the intergovernmental panel on climate change* (pp. 174-235). Cambridge, United Kingdom and New York: Cambridge University Press.

Rosenzweig, C., Cassassa, G., Karoly, D. J., Imeson, A., Liu, C., Menzel, A., Rawlins, S., Root, T. L., Seguin, B., & Tryjanowski, P. (2007). Assessment of observed changes and responses in natural and managed systems. In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, & C. E. Hanson (Eds.), *Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the fourth assessment report of the intergovernmental panel on climate change* (pp. 79-131). Cambridge: Cambridge University Press.

Salkind, N. J. (2010). Demographics In: Encyclopedia of Research Design Encyclopedia. Retrieved from DOI:https://dx.doi.org/10.4135/9781412961288.n108.

Sarantakos, S. (1997). *Social research* (2nd ed.). New York: Palgrave Publishers Ltd.

Saunders, M., Lewis, P., & Thornhill, A. (2012). *Research methods for business students* (6th ed.). Edinburgh Gate: Financial Times, Prentice Hall.

Schiro, M. S. (2007). *Curriculum theory: Conflicting visions and enduring concerns*. Boston College USA: SAGE Publications.

Schmidhuber, J., & Tubiello, F. N. (2007). *Climate change and food security special feature: Global food security under climate change*. Proceedings of National Academy of Sciences USA 104, 19703–19708.

Schunk, D. H. (2000). *Learning theories and educational perspectives* (3rd ed). New Jersey: Prentice- Hall, Inc.

Shah, M., Haq, A., & Ahmed, K. J. (2019). Is fertility preference related to perception of the risk of child mortality, changes in landholding, and type of family? A comparative study on populations vulnerable and not vulnerable to extreme weather events in Bangladesh. *Population Review, 58*(2), 61-99.

Shaughnessy, J., Zechmeister, E., & Jeanne, Z. (2011). *Research methods in psychology* (9th ed.). New York, NY: McGraw Hill.

Shi, R., & Pass, E. (2016). *Hybrid consensus: Efficient consensus in the permissionless model*. Retrieved from http://www.initc3.org.

Smit, B., & Skinner, M. W. (2002). Adaptation options in agriculture to climate change: A typology. *Mitigation and Adaptation Strategies for Global Change, 7*(1), 85–114.

Smith, N., & Leiserowitz, A. (2012). The rise of global warming skepticism: Exploring affective image associations in the United States over time. *Risk Analysis, 32*(6), 1021-1032.

Spellman, G., Field, K., & Sinclair, J. (2003). Assessing UK higher students' awareness of global climate change. *Weather, 58*(6), 212-219.

Steffen, W., Rockström, J., Richardson, K., Lenton, T. M., Folke, C., Liverman, D., Summerhayes, C. P., Barnosky, A. D., Cornell, S. E., Crucifix, M., Donges, J. F., Fetzer, I., Lade, S. J., Scheffer, M., Winkelmann, R., & Hans, J. S. (2018). Trajectories of the earth system in the Anthropocene. *Proceedings of the National Academy of Sciences* (pp. 8252–8259). Retrieved from http://doi:10.1073/pnas.1810141115.

Stephen, K., Kibett, J., & Obaro, J. (2014). Perceptions of teachers towards the integration of adaptation strategy topics on climate change into secondary school agriculture syllabus in Machakos County, Kenya. *Journal of Research and Method in Education, 4*(5), 35-49.

Study Mode Research (2021). *Climate*. Retrieved from https://www.studymode.com/essays/climate-50942771.html.

Sutter, J. D., & Berlinger, J. (2015). Final draft of climate deal formally accepted in Paris. *Cable News Network, Turner Broadcasting System, Inc*. Retrieved from http://www.cnn.com/2015/12/12/world/global climate-change-conference-vote.

Suyatna, A., & Rosidin, U. (2017). Teachers and students' knowledge about global warming: A study in smoke disaster area of Indonesia. *International Journal of Environmental and Science Education. 12*(4). 777-785.

The Radical Emission Reduction Conference (2013). Retrieved from http://www.tyndall.ac.uk/radical-emission-reduction-conference-1011-december-2013-register-here.

The World Bank Group (2013). *Combating climate change in Africa*. Retrieved from http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/0,contentMDK:22410211~pagePK:146736~piPK:146830~theSitePK:258644,00.html.

Trenberth, K. E., Jones, P. D., Ambenje, P., Bojariu, R., Easterling, D., Klein Tank, A., Parker, D., Rahimzadeh, F, Renwick, J. A., Rusticucci, M., Soden, B., & Zhai, P. (2007). Observations: Surface and atmospheric climate change. In S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, & H. L. Miller (Eds.), *Climate change 2007: The physical science basis. Contribution of Working Group I to the fourth assessment report of the intergovernmental panel on climate change* (pp. 235–336). Cambridge: Cambridge University Press.

UK Royal Society (2009). *Geoengineering the climate: Science, governance and uncertainty*. London: UK Royal Society.

UN Report (2019). *The sustainable development goals*. New York: United Nation.

UNEP (2009). *Climate change*. Paris: UNEP.

UNESCO (2010). *Climate change education for sustainable development*. Paris: UNESCO.

UNISDR (2009). *Regional analysis on disaster risk reduction education in the Asia and Pacific region in the context of HFA priority three implementation*. Bangkok: Scand-Media Corp., Ltd.

United Nations (2009). *United Nations framework convention on climate change: Conference on the parties (Fifteenth Session)*. Copenhagen: United Nations.

United Nations Framework Convention on Climate Change [UNFCCC] (2002). *Full text of the convention, article 2: Objectives*. Bonn: UNFCCC.

United Nations Framework Convention on Climate Change [UNFCCC] (2007). *Climate change: Impacts, vulnerabilities and adaptation in developing countries*. Bonn: UNFCCC.

United Nations Framework Convention on Climate Change [UNFCCC] (2011). Action taken by the conference of the parties at its sixteenth session. *Report of the conference of the parties on its sixteenth session* (p.3). Geneva, Switzerland: United Nations.

United Nations Framework Convention on Climate Change [UNFCCC] (2013). *Introduction to the convention*. Bonn: UNFCCC.

United Nations Framework Convention on Climate Change [UNFCCC] (2019). *Cut global emissions by 7.6 percent every year for next decade to meet 1.5°C Paris target*. Paris: United Nations.

US National Research Council [US NRC] (2011). *Climate stabilisation targets: Emissions, concentrations, and impacts over decades to millennia.* Washington, D.C.: National Academies Press.

van Vuuren, D. P., Stehfest, E., den Elzen, M. G. J., Kram, T., van Vliet, J., Deetman, S., Isaac, M., Klein, G. K., Hof, A., Mendoza, B. A., Oostenrijk, R., & van Ruijven, B., (2011). RCP2.6: Exploring the possibility to keep global mean temperature increase below 2°C. *Climatic Change, 109*(95), 95-116.

Verlag, F., & Muller, V. C. F. (1992). *Climate change: A threat to global development*. Bonn: Bonn Universities Buchdruckerei.

Victor, D., Zhou, D., & Ahmed, E. (2014). Introductory chapter. In O. Edenhofer, P. R. Madruga, & Y. Sokona (Eds.), *Climate change: Mitigation of climate change contribution of working group III to the fifth assessment report of the intergovernmental panel on climate change* (pp. 111-150). Cambridge, United Kingdom, UK and New York, NY: Cambridge University Press.

Wheaton, E. E., & Maciver, D. C. (1999). A framework and key questions for adapting to climate variability and change. *Mitigation and Adaptation Strategies for Global Change, 4*(3), 215–225.

Whigan, E. J. (2014). *Region IVA - calabarzon, Philippines*. Retrieved from https://ph.linkedin.com/in/eunice-joy-whigan-abaa5092.

Wikimedia Foundation Inc. (2013). *Climate change in Africa.* Retrieved from http://en.wikipedia.org/wiki/Climate_change_in_AfricaClimatechange inAfrica

Yang, X., Wei, L., & Su, Q. (2020). How is climate change knowledge distributed among the population in Singapore? A demographic analysis of actual knowledge and illusory knowledge. *Sustainability, 12*(3782), 3782.

Yohe, G., & Tol, R. S. J. (2002). Indicators for social and economic coping capacity: Moving toward a working definition of adaptive capacity. *Global Environmental Change, 12*(1), 25–40.

Yohe, G. (2000). Assessing the role of adaptation in evaluating vulnerability to climate change. *Climatic Change, 46*(3), 371–390.

APPENDICES

APPENDIX A

QUESTIONNAIRE FOR TEACHERS

UNIVERSITY OF CAPE COAST

DEPARTMENT OF BUSINESS AND SOCIAL SCIENCES

EDUCATION

Dear respondent,

The aim of this questionnaire is to solicit information with regard to demographic characteristics of senior high school teachers' influence on knowledge on climate change. I would be very grateful if you could provide answers to the questionnaire items. Any information you provide would be treated with utmost confidentiality and besides, your anonymity is guaranteed.

SECTION A

DEMOGRAPHIC DATA

Please write or tick [√] the appropriate response(s)

1. Gender: Male [ ] Female [ ]
2. Age

   [ ] 25- 35years [ ] 36- 46years [ ] 47- 57years Above 57 years
3. Highest educational qualification (please tick any one)

   [ ] Teacher's Diploma

   [ ] Higher National Diploma

   [ ] Bachelor's Degree

   [ ] Postgraduate Certificate/Degree

   Other (please specify).....

4. Subject taught in your school:

[ ] Social Studies [ ] Integrated Science [ ] Geography [ ]

Agricultural science [ ] Biology Other (please specify).....

5. Indicate level taught in your school:

[ ] SHS 1

[ ] SHS 2

[ ] SHS 3

6. What is your income level?

[ ] low (below Gh₵ 2,000)

[ ] middle (Gh₵2,000- 3,000)

[ ] high (above Gh₵ 3,000)

SECOND PART

(B) TEACHERS' KNOWLEDGE ON CLIMATE CHANGE

In each of the following statements, indicate your knowledge of climate change causes by ticking (√)				
Climate change is caused by:	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
7. Excess Carbon dioxide (CO_2) in the atmosphere				
8. Chlorofluorocarbons (CFCs)				
9. Depletion of the ozone layer				
10. The burning of fossil fuel				
11. Variation in the sun's energy				
12. Ocean circulation (current)				

13. Cutting-down of trees and bush burning				
14. Building of cities				
15. Irrigation of the desert				
16. Volcanic eruption				

In each of the following statements, indicate your knowledge of climate change effects by ticking (√)				
Impacts of climate change are:	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
17. more intense and longer droughts have been observed over wider areas mostly in the dry tropics and subtropics				
18. precipitation is not likely to increase as is expected in many high-latitude regions				
19. increases in the already high temperatures which lead to large evaporation losses in many developing countries				
20. large effects are related to enhanced glacial melt affecting river flows				
21. inundation (flooding) of cities and infrastructure due to sea level rise and higher disease burden				
22. change on world market prices of agricultural and fisheries products				
In each of the following statements, indicate your knowledge of climate change mitigation by ticking (√)				
Climate change is mitigated by:	**Strongly**	**Disagree**	**Agree**	**Strongly**

	Disagree			Agree
23. the high demand for wind energy and sunlight				
24. increasing the capacity of carbon sinks such as land and forest				
25. retrofitting buildings to make them more energy efficient				
26. adopting renewable energy sources like solar, wind and small hydro				
27. helping cities develop more sustainable transport such as bus rapid transit, electric vehicles				
28. the use of biofuels from crop wastes				
29. abolishing fossil fuel subsidies				
30. a phase-out of coal emissions				
31. stop digging for more fossil fuels				

In each of the following statements, indicate your knowledge of climate change adaptation by ticking (√)

Ability to adapt to climate change is by:	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
32. building river and sea defence walls				
33. home level disaster preparedness				

34. changes in farming practices/promotion of appropriate cultivation methods				
35. changes in building regulations				
36. restoring and maintaining wetlands, mangrove swamps, and salt marshes				
37. strengthening of measures to prevent outbreaks of infectious diseases				
38. construction of green roofs, porous pavement and parks, and community gardens				
39. the introduction of heat resistant crop varieties				
40. systematic water supply development to cope with recent frequent droughts.				

APPENDIX B

QUESTIONNAIRE FOR STUDENTS

UNIVERSITY OF CAPE COAST

DEPARTMENT OF BUSINESS AND SOCIAL SCIENCES

EDUCATION

Dear respondent,

The aim of this questionnaire is to solicit information with regard to demographic characteristics of senior high school students' influence on knowledge on climate change. I would be very grateful if you could provide answers to the questionnaire items. Any information you provide would be treated with utmost confidentiality and besides, your anonymity is guaranteed.

SECTION A

DEMOGRAPHIC DATA

1. Gender: Male [ ] Female [ ]
2. Age

[ ] 13 to 16 years

[ ] 17 to 20 years

[ ] Above 20 years

3. Programme of Study (Please tick anyone)

[ ] General Arts

[ ] Business

[ ] General Science

[ ] Visual Arts

[ ] Home Economics

[ ] Agricultural Science

4. Which religion do you belong?

[ ] Christianity

[ ] Islamic

[ ] African Traditional

[ ] Other (please specify).....

5. Is your mother educated?

[ ] yes

[ ] no

6. What is your mother's educational level?

[ ] diploma

[ ] degree

[ ] masters

Others (please specify).....

7. Is your father educated?

[ ] yes

[ ] no

8. What is your father's educational level?

[ ] diploma

[ ] degree

[ ] masters

Others (please specify).....

9. Have you participated in climate change workshops before?

[ ] yes

[ ] no

10. If yes, indicate the name of the workshop.....

11. Are you a member of climate change club(s) in your school?

[ ] yes

[ ] no

12. If yes indicate the name of the climate change club(s) in your school.....

13. Are you experiencing climate change impacts in your region of residence?

[ ] yes

[ ] no

14. If yes, indicate the name of your region of residence where you are experiencing climate change impacts.....

15. Which household do you belong?

[ ] low income household (below Gh₵ 2,000)

[ ] middle income household (Gh₵2,000- 3,000)

[ ] high income household (above Gh₵ 3,000)

SECTION B

STUDENTS' KNOWLEDGE ON CLIMATE CHANGE

In each of the following statements, indicate your knowledge of climate change causes by ticking (√)				
Climate change is caused by:	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
16. Excess Carbon dioxide (CO_2) in the atmosphere				
17. Chlorofluorocarbons				

(CFCs)				
18. Depletion of the ozone layer				
19. The burning of fossil fuel				
20. Variation in the sun's energy				
21. Ocean circulation (current)				
22. Cutting-down of trees and bush burning				
23. Building of cities				
24. Irrigation of the desert				
25. Volcanic eruption				
26. Meat consumption				
27. Waste generation				

In each of the following statements, indicate your knowledge of climate change impacts by ticking (√)

Impacts of climate change are:	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
28. more intense and longer droughts have been observed over wider areas mostly in the dry tropics and subtropics				
29. precipitation is not likely to increase as is expected in many high-latitude regions				
30. increases in the already high temperatures which lead to large evaporation losses in many developing countries				
31. large effects are related to enhanced glacial melt affecting river flows				

32. inundation (flooding) of cities and infrastructure due to sea level rise and higher disease burden				
33. change on world market prices of agricultural and fisheries products				
34. conflicts on water, gender inequalities and job insecurity.				

In each of the following statements, indicate your knowledge of climate change mitigation by ticking (√)				
Climate change is mitigated by:	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
35. the high demand for wind energy and sunlight				
36. increasing the capacity of carbon sinks such as land and forest				
37. retrofitting buildings to make them more energy efficient				
38. adopting renewable energy sources like solar, wind and small hydro				
39. helping cities develop more sustainable transport such as bus rapid transit, electric vehicles				
40. the use of biofuels from crop wastes				
41. abolishing fossil fuel subsidies				
42. a phase-out of coal				

emissions				
43. stop digging for more fossil fuels				

In each of the following statements, indicate your knowledge of climate change adaptation by ticking (√)				
Ability to adapt to climate change is by:	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
44. building river and sea defence walls				
45. home level disaster preparedness				
46. changes in farming practices/promotion of appropriate cultivation methods				
47. changes in building regulations				
48. restoring and maintaining wetlands, mangrove swamps, and salt marshes				
49. strengthening of measures to prevent outbreaks of infectious diseases				
50. construction of green roofs, green walls, porous pavement and parks, and community gardens				
51. the introduction of heat resistant crop varieties				
52. systematic water supply development to cope with recent frequent droughts.				

APPENDIX C

KREJCIE AND MORGAN SAMPLING TABLE

TABLE 1

Table for Determining Sample Size from a Given Population

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size. *S* is sample size.

Source: Krejcie & Morgan, 1970

APPENDIX D

SPSS TEACHERS' OUTPUT

Levene's Test of Equality of Error Variances[a]

Dependent Variable: average knowledge

F	df1	df2	Sig.
1.612	98	101	.009

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

Tests of Between-Subjects Effects

Dependent Variable: average knowledge

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	38.555[a]	98	.393	1.120	.286	.521
Intercept	339.535	1	339.535	966.638	.000	.905
Gender	.254	1	.254	.724	.397	.007
Age	1.109	2	.555	1.579	.211	.030
Highest Educational Qualification	.199	2	.099	.283	.754	.006
Subject taught in your school	1.335	5	.267	.760	.581	.036
Level taught in your school	.574	2	.287	.818	.444	.016
Income level	.191	2	.096	.272	.762	.005
Gender * Age	.153	1	.153	.435	.511	.004
Gender * Highest	.332	1	.332	.944	.334	.009

Educational Qualification Gender * Subject taught in your school	1.036	5	.207	.590	.708	.028
Gender * Level taught in your school	.262	2	.131	.373	.690	.690
Gender * Income level	.004	1	.004	.013	.911	.000
Highest Educational Qualification	.000	0	.	.	.	.000
Age * Subject taught in your school	2.200	6	.367	1.044	.402	.058
Age * level taught in your school	2.479	3	.826	2.352	.077	.065
Age * Income level	.000	0	.	.	.	.000
Highest Educational Qualification * Subject taught in your school	1.833	5	.367	1.044	.396	.049
Highest Educational Qualification * level taught in	.085	2	.043	.122	.886	.002

your school						
Highest Educational Qualification * Income level	.414	1	.414	1.179	.280	.012
Subject taught in your school * level taught in your school	6.264	10	.626	1.783	.073	.150
Subject taught in your school * Income level	.001	1	.001	.003	.953	.000
Level taught in your school * Income level	.870	2	.435	1.239	.294	.024
Gender * Age * Highest Educational Qualification	.000	0	.	.	.	.000
Gender * Age * Subject taught in your school	.000	0	.	.	.	.000
Gender * Age * level taught in your school	.000	0	.	.	.	.000
Gender * Age * Income level	.000	0	.	.	.	.000
Gender * Highest Educational Qualification * Subject taught in your school	.169	2	.085	.241	.786	.005
Gender * Highest	.010	1	.010	.028	.868	.000

Educational Qualification * level taught in your school						
Gender* Highest Educational Qualification * Income level	.000	0	.	.	.	.000
Gender * Subject taught in your school * level taught in your school	.846	6	.141	.401	.877	.023
Gender * Subject taught in your school * Income level	.000	0	.	.	.	.000
Gender * level taught in your school * Income level	.000	0	.	.	.	.000
Age * Highest Educational Qualification * Subject taught in your school	.000	0	.	.	.	.000
Age * Highest Educational Qualification *level taught in your school	.000	0	.	.	.	.000
Age * Highest	.000	0	.	.	.	.000

Educational Qualification * Income level						
Subject taught in your school * Level taught in your school	3.472	3	1.157	3.295	.024	.089
Age * Subject taught in your school * Income level	.000	0	.	.	.	.000
Age * level taught in your school * Income level	.000	0	.	.	.	.000
Highest Educational Qualification * Subject taught in your school * level taught in your school	2.521	6	.420	1.196	.315	.066
Highest Educational Qualification * Subject taught in your school * Income level	.000	0	.	.	.	.000
Highest Educational Qualification * level taught in your school * Income level	.000	0	.	.	.	.000
Subject taught in your school * level taught in your school * Income level	.000	0	.	.	.	.000

Gender * Age * Highest Educational Qualification * Subject taught in your school	.000	0	.	.	.	.000
Gender * Age * Highest Educational Qualification * Income level	.000	0	.	.	.	.000
Gender * Age * Subject taught in your school * level taught in your school	.000		.	.	.	.000
Gender * Age * Subject taught in your school * Income level	.000	0	.	.	.	.000
Gender * Age * level taught in your school * Income level	.000	0	.	.	.	.000
Gender * Highest Educational Qualification * Subject taught in your school * level taught in your school	.000	0	.	.	.	.000
Gender * Highest Educational	.000	0	.	.	.	.000

Qualification * Subject taught in your school * level taught in your school						
Gender*Highest Educational						
Qualification * Subject taught in your school * Income level	.000	0	.	.	.	.000
Gender * Highest Educational						
Qualification * level taught in your school * Income level	. 000	0	.	.	.	.000
Gender * Subject taught in your school * Highest Educational	.000	0	.	.	.	.000
Qualification * Subject taught in your school * level taught in your school	.000	0	.	.	.	.000
Age * Highest Educational						
Qualification * Subject taught in your school * Income level	.000	0	.	.	.	.000

Age * Highest Educational Qualification * level taught in your school * Income level	.000	0	.	.	.	.000
Age * Subject taught in your school * level taught in your school * Income level	.000	0	.	.	.	.000
Highest Educational Qualification * Subject taught in your school * level taught in your school * Income level	.000	0	.	.	.	.000
Gender * Age * Highest Educational Qualification * Subject taught in your school * level taught in your school	.000	0	.	.	.	.000
Gender * Age * Highest Educational Qualification * Subject taught in your school * Income level	.000	0	.	.	.	.000
Gender * Age *	.000	0	.	.	.	.000

Highest Educational Qualification * level taught in your school * Income level						
Gender * Age * Subject taught in your school * level taught in your school * Income level	.000	0	.	.	.	.000
Gender * Highest Educational Qualification * Subject taught in your school * level taught in your school * Income level	.000	0	.	.	.	.000
Age * Highest Educational Qualification * Subject taught in your school * level taught in your school * Income level	.000	0	.	.	.	.000
Gender * Age * Highest Educational	.000	0	.	.	.	.000

taught in your school * Income level						
Error	35.477	101	.351			
Total	2032.859	200				
Corrected Total	74.031	199				

a. R Squared = .521 (Adjusted R Squared = .056)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Average Causes of Climate	200	1.00	5.70	3.0330	.71573
Average Impact of Climate	200	1.00	4.00	3.1375	.72570
Average Mitigation of Climate	200	1.00	4.00	3.1856	.71785
Average Adaptation of Climate	200	1.00	4.00	3.1756	3.1756
Valid N (listwise)	200				

Report average knowledge

Age	Mean	N	Std. Deviation
25-35years	3.1083	155	.62547
36-46years	3.2113	38	.55338
47-57years	3.2727	7	.71518
Total	3.1336	200	.61436

Report average knowledge

Subject taught in your school	Mean	N	Std. Deviation
Social Studies	2.9953	32	.89109
Integrated Science	3.1950	39	.64877
Geography	3.2612	29	.42582
Agricultural Science	3.0852	16	.75456
Biology	3.2256	36	.52638
Other	3.2256	48	.44347
Total	3.0461	200	.61436

Report average knowledge

Level taught in your school	Mean	N	Std. Deviation
SHS 1	3.0204	46	.80687
SHS 2	3.1058	69	.53756
SHS 3	3.2175	85	.54470
Total	3.1336	200	.61436

APPENDIX E

SPSS STUDENTS' OUTPUT

Statistics

	Causes of climate change	Impacts of climate change	Mitigation of climate change	Adaptation of climate change
Valid N	279	279	279	279
Missing	0	0	0	0
Mean	2.6822	2.7522	2.7037	2.7593
Std. deviation	.51734	.59289	.53603	.57361
Range	3.00	6.86	2.67	2.83

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Average knowledge	279	1.68	4.00	2.7243	.42753
Valid N (listwise)	279				

Levene's Test of Equality of Error Variances[a]

Dependent Variable: average knowledge

F	df1	df2	Sig.
1.415	207	71	.045

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + gender + age + programme of study + which religion you belong + what is your mother's educational level + what is your father's educational level + have you participated in climate change workshop before + Are you a member of climate change club in your school + climate change impact in your region of residence + which household do you belong?

Tests of Between-Subjects Effects

Dependent Variable: Average knowledge

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	8.161[a]	22	.371	2.226	.002	.161
Intercept	60.704	1	60.704	364.348	.000	.587
Gender	.272	1	.272	1.630	.203	.006
Age	1.431	2	.715	4.294	.015	.032
Programme of study	3.895	5	.779	4.675	.000	.084
Which religion do you belong to	.634	3	.211	1.268	.286	.015
What is your mother's educational level	.179	3	.060	.358	.783	.004
What is your father's educational level	.363	3	.121	.726	.537	.008
Have you participated in climate change workshop before	.008	1	.008	.051	.822	.000
Are you a member of climate change club in your school	.055	1	.055	.328	.567	.001
Climate change impact in your region of residence	.239	1	.239	1.436	.232	.006
Which household do you belong	.216	2	.108	.650	.523	.005
Error	42.652	256	.167			

Total	2121.551	279				
Corrected Total	50.813	278				

a. R Squared = .161 (Adjusted R Squared = .088)

Multiple Comparisons

Dependent Variable: Average knowledge

Scheffe

(I) Programme of study	(J) Programme of study	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
General Arts	Business	-.0749	.09053	.984	-.3785	.2287
	General Science	-.2743*	.06821	.008	-.5031	-.0456
	Visual Arts	-1.622	.07669	.485	-.4194	.0950
	Home Economics	.0456	.10513	.999	-.3069	.3982
	Agricultural Science	-.3412	.09789	.036	-.6695	-0129
Business	General Arts	.0749	.09053	.984	-.2287	.3785
	General Science	-1.994	.10170	.573	-.5405	.1416
	Visual Arts	-.0873	.10756	.985	-.4480	.2734
	Home Economics	.1205	.12939	.972	-.3134	.5545
	Agricultural Science	-.2663	.12358	.463	-.6807	.1481
General Science	General Arts	.2743*	.06821	.008	.0456	.5031
	Business	.1994	.10170	.573	-.1416	.5405
	Visual Arts	.1121	.08960	.905	-.1884	.4126
	Home Economics	.3200	.11489	.175	-.0654	.7053
	Agricultural Science	-.0669	.10831	.996	-.4301	.2963
Visual Arts	General Arts	.1622	.07669	.485	-.0950	.4194

Visual Arts	Business	.0873	.10756	.985	-.2734	.4480
	General Science	-.1121	.08960	.905	-.4126	.1884
	Home Economics	.2079	.12012	.701	-.1950	.6107
	Agricultural Science	-.1790	.11384	.780	-.5607	.2028
	General Arts	-.0456	.10513	.999	-.3982	.3069
Home Economics	Business	-.1205	.12939	.972	-.5545	.3134
	General Science	-.3200	.11489	.175	-.7053	.0654
	Visual Arts	-.2079	.12012	.701	-.6107	.1950
	Agricultural Science	-.3868	.13465	.147	-.8384	.0647
	General Arts	.3412*	.09789	.036	.0129	.6695
Agricultural Science	Business	.2663	.12358	.463	-.1481	.6807
	General Science	.0669	.10831	.996	-.2963	.4301
	Visual Arts	.1790	.11384	.780	-.2028	.5607
	Home Economics	.3868	.13465	.147	-.0647	.8384

Based on observed means.
The error term is Mean Square (Error) = .167
* The mean difference is significant at the .05 level.

Descriptives

Average knowledge

	N	Mean	Std. deviation	Std. Error	95% Confidence level for mean		Mini Mum	Maxi mum
					Lower Bound	Upper Bound		
General Arts	133	2.6271	.39506	.03426	2.5593	2.6949	1.68	4.00
Business	24	2.7020	.46796	.09552	2.5044	2.8996	1.68	3.53
General Science	49	2.9014	.35194	.05028	2.8003	3.0025	1.70	3.71
Visual Arts	36	2.7893	.49137	.08189	2.6231	2.9556	1.99	3.97
Home Economics	17	2.5815	.45791	.11106	2.3460	2.8169	1.71	3.37
Agricultural Science	20	2.9683	.39259	.08778	2.7847	3.1520	2.29	3.47
Total	279	2.7243	.42753	.02560	2.6739	2.7747	1.68	4.00