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Tertiary Institutions in Ghana Curriculum Coverage on Climate Change: Implications for Climate Change Awareness.

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Abstract
Global problems such as climate change, which have deeper implications for survival of mankind on this planet, needs to be given wider attention in the quest for knowledge. It is expected that, improved knowledge derived from curriculum coverage may promote greater public awareness of such important global issue. This research aims at examining the extent to which tertiary institutions cover issues related to climate change in their curriculum and to determine the implications of such coverage on climate change awareness in the public domain. The findings revealed that out of a total of 1,478 courses offered in the Sciences in the University of Ghana, only 14 of them treat topics related to climate change. Due to the limited coverage of climate change issues in the curriculum of the institutions, graduates from such institutions may not be knowledgeable in climate change issues. They and members of their communities may, therefore, not be aware of most climate change issues including lifestyle and its influence on climate change, climate change measurements, climate change and its implication on health, and packaging and dissemination of climate change information.
Key words: Climate change, climate change curriculum, knowledge, global warming.

Introduction

Global problems such as climate change which have deeper implications for survival of mankind on this planet needs to be given wider attention in all our institutions of learning. Climate Change is the description of variations from the long term natural climate equilibrium, produced by the anthropogenic changes to the atmospheric composition. Global warming, the long-term increase in average temperatures, is the most important manifestation of climate change. According to Kevin Trenberth, (2011) senior scientist at the U.S. National Center for Atmospheric Research's Climate Analysis Section."Global warming has increased temperatures and directly related to that is an increase in the water-holding of the atmosphere. Over the ocean, where there are no water limitations, observations confirm that the amount of water vapour in the atmosphere has increased by about 4 percent, consistent with a 1 degree F warming of sea surface temperatures since about the 1970s. The human component does not change much from year to year and affects all storms." Global warming has been predicted and scientifically shown to be caused by the increase of carbon dioxide in the atmosphere by human activities that enhance the natural greenhouse effect.

The effects of climate change, including sea level rise, desertification, glacial melting, and water shortages, all contribute to increasing security threats due to corresponding changes in geography and increased competition for natural resources.

On Earth Day, April 22, 2010 President Dale T. Knobel of Denison University signed the American College and University Presidents' Climate Commitment. The accord is a commitment by institutions of higher education to exercise leadership in their communities and throughout society by modelling ways to minimize global warming emissions, and by providing the knowledge and the educated graduates to achieve climate neutrality.The above is an indication of the important role that educational institutions can play in issues related to climate change to promote behaviours that can help curb the detrimental effects of climate change on mankind.

Climate change is the greatest public policy issue of our time. According to Stephen Hawking, he warned scientist". As we stand at the brink of a second nuclear age and a period of unprecedented climate change, scientists have a special responsibility, once again to inform the public and to advise leaders about the perils that humanity faces," he said. "As scientists we understand the dangers of nuclear weapons and their devastation effects, and we are learning how human activities and technologies are affecting climate systems in ways that may forever change life on Earth. If humanity is to respond to the challenges, education has a key role to play in promoting understanding and helping individuals, society and governments to make informed choices (Prahalad, 2009).

To what extent have tertiary institutions in Ghanaian universities covered issues related to climate change in their curriculum, and what possible implications will such coverage on climate change have on climate change awareness in the public domain? According to (Prahalad, 2009), responding to the challenges of climate change is not simply about giving people information, but ensuring that education – and schools specifically – is mobilized to re-orient society towards sustainable practices.

The accumulation of greenhouse gases in Earth's atmosphere - the primary driver of modern climate change (Climatelab, 2011) is a result of human activities, including transportation, land-clearing, and production of electricity and consumer products. The global impact of these activities is no more than the outcome of each individual human's activities and behaviours. Collectively, individuals form societies, communities, villages, towns and metropolis. Individuals with adequate knowledge about the consequences of their behaviour on climate change may develop positive attitudes towards such behaviours, and subsequently modify such behaviours. Individual behaviour is more and more becoming predictable as an appropriate angle from which to tackle climate mitigation and adaptation. Climate change solutions at the scale of the individual often centre on three degrees of human behaviour: Consumption, lifestyle, and culture. How have the curriculum of Universities captured the contributions that consumption, lifestyle, and culture make towards climate change?

Information is very important in all human endeavours, especially on issues that relate to contemporary phenomenon such as climate change that have wider implication on human survival intervention. Information provides the basis for change in people's knowledge, attitude, practices and behaviour. In situations where change in behaviour is necessary to ensure human survival the need for well packaged information is indispensable to promote planned change. Planned change has the basic aim of changing attitudes, and behaviours. Human beings form attitudes and subsequently develop behaviours about contemporary phenomenon, technologies and techniques only after they have acquired relevant information about those technologies (Amin et al 2007).

Knowledge can be regarded as the body of mental influences and conclusions that people build from different elements of information, and which allow them to take action on a given context. It is a well- known fact that for any contemporary issue to be known by the general populace there is the need for the relevant information to be well packaged and made available and accessible to the target audience. Depending on the novelty and complexity of the phenomenon under consideration, the packaging and communication may include inclusion in the curricula of educational institutions.

This research aims at examining the extent to which tertiary institutions of selected Universities in Ghana cover issues related to climate change in their curriculum, the implications of such coverage on climate change awareness in the public domain.

Methodology

Literature search was done to determine the contemporary issues on climate change and the expected content of climate change curriculum for tertiary institutions. The course contents of College of Agriculture, faculty of Science of University of Ghana and University of Professional Studies, Accra (UPSA) (two major public universities in Ghana) were thoroughly examined to determine the topics treated on issues related to climate change. Handbooks of the Bachelor's degree (Science), University of Ghana and that of University of Professional Studies, Accra (UPSA) were used. The topics related to climate change treated by the various courses were compared with the things that people need to know about climate change derived from literature. Conclusions were drawn on the expected level of awareness of the public about climate change issues.

Findings

The findings of this research are twofold; they are what needs to be known about climate change derived from literature, and the extent of coverage of climate change issues in the curriculum of University of Ghana and University of Professional Studies, Accra.

What needs to be known about climate change?

The term "climate change" generally has a connotation of being about the future, and in particular about future warming induced by emissions of greenhouse gases by humans. Indeed, the United Nations Framework Convention on Climate Change (UNFCCC, 1994), the UN agreement coordinating international measures to tackle climate change, defined climate change as such (United Nations 1992). It is believed that a variety of

factors can influence the climate, including human activities other than greenhouse gas emissions and factors completely unrelated to humans. In light of this, the most recent report of the Intergovernmental Panel on Climate Change (IPCC, 2007) assessing progress in global research of climate change, commissioned by the UNFCCC, adopted a more widespread definition of climate change as follows;"climate change is occurring now, mostly as a result of human activities, this volume illustrates the impacts of global warming already under way and the potential for adaptation to reduce the vulnerability to, and risks of climate change."

The statistics of weather measured over some period, such as 30 years (Dunlop, 2007). This definition seems inadequate, however, both because it is purely based on measurement rather than some integral property of a system and because it implicitly denies that the climate can change. A more robust definition, as proposed by some reviewers, is that the climate is itself the statistical properties of possible weather, with the actual observed weather being just one realization of many possible realizations within a given climate

Human kind also needs to know how many different factors could conceivably influence the climate. How many different factors, other than climate change, could also be influencing an ecosystem or drainage basin? At the personal level, is the warming on our properties a consequence of global emissions, or is it a consequence of industralisation or of the felling of trees in the communities? The relationship between human activities and global warming must be known.

It is widely recognised that global climate change is already having long-term health consequences, which expose people to conditions that can result in illness and death, due to respiratory illness, such as asthma, heat-related stress, effects of flooding and colder weather, and insect-borne diseases. Furthermore, increased UV radiation has increased the incidences of skin cancer.

It has been proposed that simple, yet effective ways to reduce carbon footprint and lessen the impact climate change and global warming are:(Carbonfootprint, 2014)
• Reduce driving and cycle to work; This will improve general fitness, reduce your risk of being overweight/obese and have a positive impact on your mental health
• Shop locally , reduce, reuse, recycle and turn it off all electrical equipment not in use

What each stakeholder needs to know about climate change is whether the greenhouse gas emissions (or other forcing) are affecting a specific ecosystem, to the hydrologist whether the emissions are affecting runoff in a particular basin and to the health authority whether the emissions are altering local environmental conditions. The difficulties encountered when analysing climate variables are compounded when extending detection and attribution studies to non-climate systems (Parry, M. L., 2007).Observational measurements of non-meteorological quantities are very often of poorer quality than for meteorological quantities (at least in the context of long-term monitoring), the modelling has an extra layer (or more) of complexity, and the simplifying assumption of linearity can be dubious.
Researchers have, for the past few years, investigated into contemporary issues associated with climate change and have come out with things that human beings need to know about climate change. Most prominent among such presentations is the document written by Hassol (2002). Among the things that Hassol (2002) proposed include the following:
Global warming is caused primarily by carbon dioxide from burning coal, oil and gas. Certain gases that trap heat are building up in Earth's atmosphere. The primary culprit is carbon dioxide, released from burning coal, oil and natural gas in power plants, cars, factories, etc.
Earth's average temperature has risen about 1 degree F in the past 100 years and is projected to rise another 3 to 10 degrees F in the next 100 years. While Earth's climate has changed naturally throughout time, the current rate of change due to human activity is unprecedented during at least the last 10,000 years(National Science Teachers Association, 2002), Ghana.
There is scientific consensus that global warming is real, is caused by human activities, and presents serious challenges. Global warming will have significant impacts on people and nature. As temperatures continue to rise, precipitation is projected to come more frequently in the form of heavy downpours. An international agreement known as the Kyoto Protocol has been negotiated to reduce greenhouse gas emissions though U.S. objected to this protocol. Protecting the world's climate by stabilizing atmospheric concentrations of greenhouse gases will require enormous reductions in current emissions. Given all this confusion and controversy, it is particularly

important that teachers and students have access to reliable information about climate change. It is our hope that this teacher's guide will be of some assistance toward that end.

From the above analysis, the following broad topics can be proposed as a guide to the development of curriculum for tertiary institutions.

- The position of global warming in climate change phenomenon
- The influence of human activities on climate change and climate change variables such as global warming, ozone layer depletion, greenhouse gas effects, and rising sea levels.
- Causes of global warming, impact/ challenges of global warming to human survival
- Effects of global warming on precipitation, flooding, and draught
- Greenhouse gases and international conventions
- Packaging and dissemination of information on climate change

Extent of climate change coverage by University of Ghana and University of Professional Studies, Accra curriculum.

Out of a total of 2 Schools and 17 Departments in College of Agriculture and Faculty of Science in the University of Ghana, under graduate level, only 8 Departments teach courses related to climate change. Out of a total of 1,798 courses offered in the Sciences in University of Ghana, only 14 of them treat topics related to climate change. Surprisingly, out of the 14 courses that have topics related to climate change, only one course, OCNO 441: "*Global Climate Change"* has been designed purposefully to cover fully issues on climate change. In the School of Agriculture where a total of 140 courses are offered at under graduate level, there is no course that treats topics related to climate change. (See Table 1) The department that treats the most number of courses in climate change is Department of Botany, where a maximum of three courses, one fully developed to cover climate change and the remaining two covering topics related to climate change.

Table 1. **Climate Change coverage; University of Ghana, Science and Agriculture Curriculum**

School/Departments	Total number of courses	Courses that treat climate change issues
School of Agriculture	140	
Family and Consumer Sciences	100	
School of Veterinary Sciences	90	
Department of Agricultural Engineering	51	1
Biomedical Engineering	55	
Food Processing Engineering	58	
Department of Material Science and Engineering	67	
Department of Physical Sciences	16	1
Animal Biology and Conservation Science	88	2
Department of Earth Science	73	1
Department of Botany	68	3
Department of Chemistry	47	2
Department of physics	82	2
Department of psychology	77	
Department of Nursing	74	
Department of Statistics	75	
Department of mathematics	63	
Department of Nutrition and Food Science	54	
Department of oceanography and Fisheries	150	2
Total number of courses	**1,478**	**14**

Table 2. Climate Change coverage; University of Professional Studies Accra

School/Departments	Total number of courses	Courses that treat climate change issues
Bachelor of Science Accounting	55	-
Bachelor of Science Banking and Finance	55	-
Bachelor of Science Marketing	54	-
Bachelor of Science Business Administration	54	-
Public Relations Management	52	-
Information Technology Development	52	-
Total number of courses	322	0

Aspects of climate change covered in University of Ghana Science and Agriculture and University of Professional Studies, Accra(UPSA)curriculum.

The following table presents aspects of climate change covered in University of Ghana Science and Agriculture curriculum. The content of the table was derived from a full analysis of all the course contents of the 1,478 courses offered in the under graduate level of School of Agriculture and the faculty of Science, University of Ghana. It also entails a full analysis of all the course contents of the 322 courses offered in the under graduate level of UPSA.

It was observed that, out of the 14 courses that treat aspects of climate change, only one course offered by the Department of Oceanography and Fisheries in University of Ghana has been developed fully for climate change; it has the topic "Global Climate Change." The remaining 13 courses have topics such as "Conservation and Environmental Studies,""Conservation Biology,""Environmental Chemistry", and "Agro Meteorology and Climatology."

As"effect and control of greenhouse""effect and global warming", "ozone depletion," "thermal pollution and global warming,""causes of climate phenomena,""climate change and other global environmental problems", and "climate change and conservation." Other topics treated by those courses include climate change and global environmental problems and their effects on biodiversity. International conservation measures. World conservation strategy. Biodiversity conventions and other international conservation treaties as shown in Table 3.

For the course labeled Global Climate Change offered by Department of Oceanography and Fisheries treat the following topics as shown in Table 3; Global climate change and the marine and coastal environment. Global warming; definition and terminologies. History and trends. Driving forces. Greenhouse gas effects. Major courses, impacts threats and opportunities for the marine and coastal environment. Sea level rise. Worldwide efforts at potential solutions and international agreement and communicating climate change.

Out of a total of 322 courses offered by UPSA there is no course developed purposely for climate change or courses that treat aspects of climate change issues. It was observed that UPSA has one course on Environmental Management taken by all degree students but the course does not cover environmental issues relevant to climate change issues.

Table 3. Aspects of climate change covered in University of Ghana Science and Agriculture and UPSAcurriculum

Departments	Courses that treat climate change issues	Aspects of climate change issues covered
Department of Chemistry	CHEM492: industrial Chemistry CHME496 Environmental Chemistry	Global warming, acid rain, smog, ozone depletion eutrophication, toxic metals and carcinogens. Effect and control of greenhouse effects and global warming. Ozone depletion chemistry of natural waters. Renewable energy and alternative fuels.
Department of physics	PHYS343: Physics of large Systems PHYS 366: physics of the atmosphere	Thermal pollution and global warming. Temperature distribution. Ozone hole. Atmospheric energy transport. Global energy balance
Department of oceanography and Fisheries	OCNO416: Coastal Ecosystems of West Africa OCNO 441: Global Climate Change	Threats and adaptations of echo systems to anthropogenic and human impact such as climate change. Global climate change and the marine and coastal environment. Global warming; definition and terminologies. History and trends. Driving forces. Greenhouse gas effects. Major courses, impacts threats and opportunities for the marine and coastal environment. Sea level rise. Worldwide efforts at potential solutions and international agreement and communicating climate change
Agricultural Engineering	AREN 40: Agro Meteorology and climatology	Net radiation measurement. Weather analysis/forecasting, physical climatology, causes of climate phenomena including heat and water balance of the earth's atmosphere,
Department of Physical Sciences	EASC104: Historical Geology	Changes in the sea level and climate.
Department of Botany	BOTN316: plant Ecology of West Africa. BOTN427 Conservation and Environmental Studies BOTN432: Whole Plant Physiology	General distribution of vegetation types in relation to climate and soils. Pollution of the environment. Climate change and other global environmental problems. Introduction of the effects of light , water, temperature pollution and climate change on plant growth and development
Department of Earth Science	EASC321: Environmental pollution	Dangers of stratospheric ozone depletion. Acid rain and deposition.
Animal Biology and Conservation Science	ABCS413: Conservation Biology	Climate change and conservation; climate change and global environmental problems and their effects on biodiversity. International conservation measures. World conservation strategy. International conservation treaties.

From the above Table it is observed that the topics treated by courses addressing climate change issues do not include lifestyle and its influence on climate change, climate change measurements, climate change and its implication on health, agricultural activities and their implication on climate change, packaging and dissemination of climate change information.

Conclusion

Looking at the total number of courses run and only 14 treating climate change issues, it can be argued that most graduates from the science and agriculture may not acquire the knowledge in climate change issues through their university education process. Specifically they may not acquire knowledge related to lifestyle and its influence on climate change, climate change measurements, climate change and its implication on health, packaging and

dissemination of climate change information. They may, therefore, not be able to develop the right attitudes and put up the required behaviours that may reduce the effects of climate change on mankind such as global warming, ozone layer depletion rise in sea levels, increase precipitation.

Since attitudes are products of socialisation and essentially acquired and learned (Chitamber1993), and formal attitudes are taught and learned consciously, students who graduate from such institution may not have the expected attitudes towards climate change that will help them to put up behaviours that may reduce climate change and its effects on humans.

Looking at the novelty of the phenomenon of climate change and issues associated with it, such as ozone layer depletion, desertification, glacial melting, rise in the earth's temperature, rise in sea levels, and greenhouse gas effects. Students from universities knowledge in the area of climate change are very important for the creation of the needed awareness in their communities. Unfortunately from the analysis of course contents of University of Ghana, Agriculture and Science courses, and University of Professional Studies, Accra UPSA; it is realised that very limited coverage of climate change issues were identified. There is no doubt that the availability of information related to climate change in the public domain may be limited. Consequently the awareness of the University of Ghana Science and Agriculture graduates, and UPSA graduates and their respective community members concerning climate change issues will be very low. It is very important that the curriculum of these two tertiary institutions should cover climate change issues to promote the awareness of climate change issues in the communities of such graduates.

From the above analysis and the issues identified from literature concerning things that need to be known about climate change the following has been proposed for the development of climate change curriculum in the University of Ghana and University of Professionals Studies Under graduate courses. Global warming and the climate change phenomenon

- The influence of human activities on climate change and climate change variables such as global warming, ozone layer depletion, greenhouse gas effects, and rising sea levels.
- Causes of global warming, impact/ challenges of global warming to human survival
- Effects of global warming on precipitation, flooding, and draught
- Greenhouse gases and international conventions
- Packaging and dissemination of information on climate change

It is expected that the following topics when treated in our tertiary institutions, will promote the awareness of climate change issues among university graduates and members in their communities.

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