Climate change science: The literacy of Geography teachers in the Western Cape Province, South Africa

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One of the universal responses to tackling global climate change is teaching climate change concepts at all levels of formal education. This response requires, among other things, teachers who are fully literate about climate change science, so that they can explain the concepts underlying the causes, impacts and solutions of climate change as accurately as possible to learners. The main intention of this study was to understand high school Geography teachers' levels of knowledge about climate change science. A 15-item, criterion-referenced, multiple-choice Climate Change Literacy Questionnaire with a reliability coefficient of 0.74 using the Guttman's spit-half test was administered to 194 high school Geography teachers in the Western Cape Province of South Africa. Data collected were analysed with the Pearson's Chi-square test and One-Way Analysis of Variance (ANOVA). The results showed that the majority of the participants demonstrated significantly high literacy levels in climate science, with their literacy levels higher in climate processes and causes of climate change than climate change impacts and solutions. Misconceptions were found in all three categories of climate change science as represented in the survey instrument. These findings suggest that teacher educators and policymakers should improve professional development programmes and support interventions in teacher knowledge and understanding of climate change concepts, so as to enhance climate change education in schools.

Keywords: climate change education; climate change misconceptions; climate change science literacy; Geography teachers; survey research

Literature Review

Scientists claim with a high degree of confidence that the Earth's climate is changing and will continue to change throughout the 21st century and beyond, but that the actual cause and the net consequences of these changes, including finding solutions, are not fully understood (Intergovernmental Panel on Climate Change (IPCC), 2014; National Research Council, 2011). The difficulty in understanding global climate change arises from the fact that the processes and driving forces inducing changes in the global climate occur slowly and are sometimes too trivial to be gauged quantitatively. Over time these creeping processes and forces become titanic in causes and consequences, to the extent that anyone seeking to analyse them might be astounded by the multiple ecological and social issues linked to them, none of which can be comprehended fully through normal scientific procedures (Moser & Dilling, 2004; Van der Sluijs, 2012).

Climate change science is a human attempt to explain the underlying concepts of climate change, particularly the processes and causes, impacts and solutions with respect to climate change (Australian Academy of Science, 2010; IPCC, 2014). Unlike a normal science that involves a specific discipline, climate change science straddles many biological, social and physical science disciplines such as Physics, Chemistry, Geography, Biology and Mathematics, as well as their sub-disciplines including atmospheric physics and chemistry; this makes climate change science an interdisciplinary enterprise. As a result, understanding the processes and causes, impacts and solutions with respect to climate change requires looking at the phenomenon of climate change in ways that creatively integrate perspectives from multiple disciplines. Due to the dynamic and uncertain nature of climate change, the application of interdisciplinary approaches used in climate change science often leads to a lack of consensus on these causes, impacts and solutions (Bhaskar, 2010; Moser, 2010).

Despite contestation among scientists on some of the underlying concepts of climate change, some progress has been made in extending knowledge and understanding of global climate change through advances in climate modelling (Edwards, 2011; Washington, New, Hawcroft, Pearce, Rahiz & Karmacharya, 2012). The IPCC Fifth Assessment Report on Climate Change released in 2014, which built on the Fourth Assessment Report published in 2007, revealed that the last three decades have shown greater consecutive warming at the Earth's surface than any decade since 1850. These changes associated with anthropogenic warming are altering atmospheric, terrestrial and hydrological systems, and further warming could have severe, pervasive and irreversible repercussions on society unless there is a sustained global response to stabilise greenhouse gas emissions. Such a response would integrate mitigation (action to reduce greenhouse gas emissions) and adaptation (adjustment in natural or human systems in response to real or potential climatic stimuli and their repercussions) (IPCC, 2007, 2014).

One of the universal responses to develop people's capacity to initiate mitigation and adaptation actions to address climate change is teaching concepts of climate change at all levels of formal education. This education project requires, among other things, teachers who have adequate information about the science of climate change so that they can present concepts as precisely and logically as possible to learners (Hestness, McDonald, Breslyn, McGinnis & Mouza, 2014; National Center for Science Education, 2012; United Nations Educational,

Scientific and Cultural Organisation (UNESCO), 2012). Supporting climate change education is the assumption that teaching concepts of climate change in schools will help to produce climate change literacy in people. According to the United States Global Change Research Programme (2009), people who are climate change literate have a basic understanding of the climate system, including the natural and human-caused factors that affect it, and understand how climate observations and records as well as computer modelling contribute to scientific knowledge about climate. They are aware of the fundamental relationship between climate and human life, as well as the various ways in which climate affects human health. They have the capacity to assess the validity of scientific arguments about climate and to use that information to support their decisions about how they should respond to climate change.

South Africa, like most African, Latin American and Asian countries, is highly vulnerable to climate change as a result of multiple stressors, including a large proportion of its population living in abject poverty, food insecurity, biodiversity degradation, and killer diseases, including tuberculosis and human immunodeficiency virus infection and acquired immune deficiency syndrome (HIV/AIDS) (Ziervogel, New, Van Garderen, Midgley, Taylor, Hamann, Staurt-Hill, Myers & Warburton, 2014). Concerned about the country's vulnerability, the South African National Climate Change Response Policy White Paper recommends teaching the concepts of climate change and related issues on all levels of formal education (Department of Environmental Affairs, Republic of South Africa, 2011). In this way South Africa shows strong support for the global initiative of tackling climate change through change education (UNESCO, 2009, 2010). Among the subjects in basic education in South Africa, Geography offers the greatest opportunity for understanding climate change concepts, because of its emphasis on place, spatial processes, spatial distribution, society and environment. Geography is taught as a sub-discipline of Social Sciences in Grades Four to Nine of the General Education and Training band and as a specific subject at the high school level in the Further Education and Training band (Grades 10 to 12) (Department of Basic Education (DBE), Republic of South Africa (RSA), 2011).

As global climate change becomes an important topic in the curriculum of many countries, it is essential for teachers to have up-to-date knowledge of the fundamentals of climate change science so that they will be able to present concepts in ways that stimulate learners' interest and develop deeper understanding. A survey of the literature revealed that there is a growing interest in research on teacher knowledge and their understanding of climate change in developing countries.

Ochieng and Koske (2013) assessed the level of climate change awareness and perception among primary school teachers using a sample of 100 participants from 20 primary schools in Kisumu Municipality, Kenya. A three-point interval scale – low (1-2), medium (2.01-3.99) and high (4-5) – was used to categorise the participants' scores on climate change awareness and their general perception of climate change. With the Pearson's Chi-Square test, the researchers determined the discrepancy between the frequency distribution.

The results indicated that the majority of the participants showed significantly low awareness of climate change, with significant gaps in their understanding of climate change. The results of this study corroborate those of Nwankwo and Unachukwu (2012), who conducted a survey involving 1,450 secondary schools in Anambra State of Nigeria in order to understand the extent to which teachers are aware of the causes and effects of climate change, and the kind of classroom management strategies they employ in providing instruction on climate change. Results of statistical analysis of data collected from the participants using structured questionnaires developed by the researchers, indicated that the teachers did not have adequate knowledge of the causes and effects of climate change or of the required strategies for management of climate change instruction. These findings also corroborate those of Boon (2010) and Ekpoh and Ekpoh (2011), who found that teachers have poor knowledge and understanding of climate change.

Vujovic (2013) investigated high school Geography teachers' knowledge and perception of climate change in addition to critiquing the Geography textbooks commonly used by Geography teachers to facilitate climate change instruction. Analysis of data gathered from 32 Geography teachers in Gauteng Province, South Africa, through semi-structured interviews, showed some gaps in teachers' understanding of climate processes as well as their limited understanding of the meaning of climate change. The study showed that the majority of the teachers have a correct understanding of climate change-induced risks, but only a few teachers had deeper scientific knowledge and understanding of climate change risks. Furthermore, the majority of the teachers held misconceptions about the appropriate mitigation strategies for climate change. These findings are in part corroborated by Bozdogan (2011), who found that Turkish teachers had knowledge gaps and certain misconceptions about the concepts underlying global warming. On the other hand, Ambusaidi, Boyes, Stanisstreet and Taylor (2012) found that teachers in Oman demonstrated an awareness of the measures humans can take to mitigate and adapt to climate change. The majority of these studies indicate that teachers have misconceptions about

climate change. The longer a misconception remains unchallenged, the more likely it is that it will become entrenched (Gooding & Metz, 2011:35).

Among the studies cited, only Vujovic (2013) investigated teachers' knowledge and perceptions of climate change with high school Geography teachers. This study is based on the assumption that teachers are among the professionals most trusted as sources of information about climate change science. For the purposes of this study, climate change science literacy refers to the basic knowledge and understanding of the science underlying the processes and causes, as well as the impacts and solutions pertinent to dealing with climate change.

The main aim of the study was to statistically determine the dimension and level of literacy regarding climate change science among Geography teachers in the Western Cape Province, South Africa, and to determine aspects of climate change science in which they are most literate. Understanding this might inform teacher educators and policymakers about the aspects of climate change in which professional development and support interventions are most needed. Furthermore, the outcomes of this study may provide prospective researchers with conceptual and methodological frameworks to investigate teachers' literacy regarding climate change science in other contexts, both internationally as well as in South Africa. Climate change is one of the most pressing problems facing humanity globally, and hence, the way in which education will respond to addressing this problem is crucial. Given the paucity of research on climate change education, the findings of this research will add to an emerging body of knowledge on the topic, both internationally and in South Africa.

Methods and Procedure
The Context of the Study
The Western Cape Province, where this study was conducted, is situated in the south-western part of South Africa. By land area, the Western Cape Province is the fourth largest province in South Africa, covering an area of 129,462 km^2, representing 10.6% of South Africa's 1,220,813 km^2 total land area. The three provinces larger in size than the Western Cape include the Northern Cape (372,889 km^2), Eastern Cape (168,966 km^2) and Free State (129,825 km^2). The population of the province is about 5.8 million people of a national population of about 51 million (Statistics South Africa, 2012). The province is ranked as one of the academically most high-achieving provinces in South Africa, based on the National School Certificate Examination Results, since 2009 (DBE, RSA, 2013). The province is divided into eight education districts: Metropole Central, Metropole South, Metropole North, Metropole East, West Coast, Cape Winelands, Overberg and Eden-Karoo,

with about 408 high school Geography teachers in total.

Research Design
The research design for this study is a descriptive, cross-sectional survey design. This design is suitable for non-experimental studies involving the analysis of data gathered by way of questionnaires or interviews from a representative sample, so that the findings can be generalised to the population from which the sample was selected.

The Sample
The survey sample was taken from 194 high school Geography teachers selected with a no-rule sampling technique, which is suitable when unfeasible for the researchers to obtain a comprehensive and accurate list of the elements in the target population used for random sampling. There was also the issue of research ethics, which gives people the right to choose whether they wish to participate in a research project or not. Confronted with these challenges, the researchers decided to select only those high school Geography teachers who indicated willingness by way of informed consent to participate in the study. The sample, representing 47.55% of the population, is distributed by district as follows: Metropole East (44), Metropole South (42), Metropole Central (39), Metropole North (24), Eden-Karoo (22), Cape Winelands (9), Overberg (8) and West Coast (6).

Data Collection
A 15-item, criterion-referenced, multiple-choice questionnaire developed by the researchers was used to collect data from the participants. The questionnaire has a reliability coefficient of 0.74, calculated with the Guttman's spit-half test. The validity of the items was determined by a panel of experts. The experts used were three leading Geography professors at South African universities, chosen because they were climate change scientists. The questionnaire consisted of three sections corresponding with the three aspects of climate change science. Section 1 collected data on climate processes and probable causes of climate change; Section 2 on the impacts of climate change; and Section 3 on solutions to climate change problems. Five content topics were selected for each section from approved school textbooks and other publications produced by the IPCC; UNESCO; the United Nations Framework Convention on Climate Change (UNFCCC), and the National Ocean and Atmospheric Administration (NOAA). Content topics on climate change processes and causes included the Earth's climate systems: global warming: natural/anthropogenic causes of climate change: global CO_2 emissions and future climates: and the nature of climate science.

Content topics on climate change impacts include the evidence of climate change in natural/human systems, climate change and water availability, the vulnerability of Sub-Saharan Africa, the effects of climate change in developing countries, and global effects of climate change. Content topics on solutions to the impacts of climate change include the stabilisation of global carbon production, rural people and their adaptation to climate change, implementation of climate change policies, mitigation and adaptation options for developing countries, and climate change response instruments. A question was developed from each content topic. The items in each section varied in depth of cognition, according to factual, conceptual and procedural questions based on Krathwohl's (2002) model of depth of cognition. Factual items assessed knowledge of basic concepts and terminology associated with climate change. Conceptual items assessed the understanding of the processes and causes, impacts and solutions in addressing climate change. Procedural items assessed the awareness of methods of solving problems relating to climate change, including the way in which these methods can be applied. A factual item is less cognitively challenging than a conceptual item, and a conceptual item less cognitively challenging than a procedural item. Hence, a factual item was allocated 1 mark, a conceptual item allocated 2 marks, and a procedural item allocated 3 marks. Each item had four options, lettered A to D. The participants were required to choose the letter, indicating the correct answer. The researchers obtained formal approval from the Western Cape Department of Education and the District Curriculum Advisors for Geography to conduct the assessment during one of the regular curriculum meetings for Geography teachers. One hundred and ninety-four high school Geography teachers willingly participated in the assessment. A sample of the questions that formed part of the survey instrument is represented in Appendix A.

Data Analysis

Each completed questionnaire was assigned an identification number to facilitate the process of capture and analysis of data. A participant's total score was obtained by tallying his or her marks for each section of the question expressed as a percentage. A scoring matrix was used to record the participants' scores on the three sections of the questionnaire. One-Way Analysis of Variance (ANOVA) was employed to make a statistical comparison between the variances of the three data sets in order to determine the extent of the variation

between them. With a five-point multiple-choice summated scale of Extremely Low (0-20), Low (21-33), Medium (34-66), High (67-100), each participant's score on each variable was categorised to determine where the participant can be located. The category with the highest frequency indicated the level where the majority of the participants clustered. The Pearson's Chi-Square Test was applied to determine whether the differences in observed frequencies are statistically significant or not. The statistical test was chosen because the study fulfilled the assumptions of sample size more than 100, independent observation, categorical data, and the individual counts not less than one. Bearing in mind that among the subjects in basic education, Geography offers the greatest opportunity for understanding climate change concepts, this study hypothesised as follows: Ho1: No significant difference will be found between the scores on different sections of the test: climate processes and causes of climate change, climate change impacts, and climate change solutions. Ho2: No significant difference will be found between the observed and the expected climate change science literacy score frequencies on climate change science. These two hypotheses were tested at 0.05 level of confidence. The results are presented below.

Results
Aspect of Climate Change Science Literacy

Table 1 shows that the mean ($\bar{x}$) and standard deviation (*SD*) of the three aspects of climate change science vary, with $\bar{x} = 65.46$ and $SD = 18.94$ for climate process and causes of climate change; $\bar{x} = 56.98$ and $SD = 22.65$ for climate change impacts; and $\bar{x} = 55.3$ and $SD = 25.4$ for climate change solutions. Among the three means, only one $\bar{x} = 65.46$ exceeded the total mean, which also lies within the upper band of the 95% confidence interval. Some participants scored zero in climate change impacts and climate change solutions, whereas the minimum score in climate processes and causes of climate change was 12.5. These facts indicate that the participants demonstrated better literacy in climate processes and causes of climate change than in climate change impacts and climate change solutions.

Data in Table 2 indicate a frequency ratio (*F*) (2.581 = 1.42, probability value (*p*) < 0.05, which suggests that there is no significant difference between the scores for the three dependent variables. Although the total variation in the entire data set is large, within-group variation is larger than between-group variation.

Table 1 Descriptive analysis of scores from the three aspects of climate change science

Aspect	$\bar{x}$	SD	$\sigma\bar{x}$	95% Confidence Interval for Mean		Min	Max
				Lower Bound	Upper Bound		
Climate processes and causes of climate change	65.46	18.94	1.36	62.78	68.15	12.50	100.00
Climate change impacts	56.98	22.65	1.63	53.78	60.19	.00	100.00
Climate change solutions	55.3	25.4	1.83	51.7	58.89	.00	100.00
Total	**59.25**	**22.89**	**.95**	**57.38**	**61.11**	**.00**	**100.00**

Table 2 Inferential analysis of the difference between the variances of scores from the three aspects of climate change science

Sources of variation	SS	df	MS	F ratio	p value
Between data sets (B)	11522.82	2	5761.41	1.42	0.046
Within data sets (W)	2344339.42	579	4048.95		
Total	**2355862.24**	**581**			

Note: *SS* = Sum of squares; *df* = degrees of freedom; *MS* = mean squares.

Level of Climate Change Science Literacy

Data in Table 3 indicates that score frequencies for the three aspects of climate change science vary. For climate processes and causes of climate change, 44.85% scored between 61 and 80, which corresponds with high literacy levels. Only one participant scored between 0 and 20, which corresponds with an extremely low literacy bracket. On climate change impacts, 29.38% demonstrated extremely high literacy, scoring between 81 and 100. Twenty-three participants (representing 11.9% of the total participants of the study) scored between 0 and 20. Pertaining to climate change solutions,

36.08% of the participants scored between 41 and 60, which corresponds with medium literacy. Nine participants (representing 4.64% of the entire sample) scored between 0 and 20. The frequency distribution shows that the participants demonstrated better literacy in climate processes and causes of climate change than in climate change impacts and climate change solutions. This evidence corroborates data in Table 1, which shows that the mean for climate processes and causes of climate change (65.46) is greater than the means for climate change impacts (56.98), and climate change solutions (55.3), respectively.

Table 3 Descriptive analysis of the score frequencies for the three dependent variables of climate change science

Aspect	0-20 Extremely Low		21-40 Low		41-60 Medium		61-80 High		81-100 Extremely High	
	n	%	n	%	n	%	n	%	n	%
Climatic processes and causes of climate change	1	0.52	32	16.49	17	8.76	87	44.85	57	29.38
Climate change impacts	23	11.9	25	12.89	47	24.23	42	21.65	57	29.38
Climate change solutions	9	4.64	28	14.43	70	36.08	65	33.51	22	11.34

Data in Table 4 indicate that 1.55% of the participants of the study fell in the extremely low literacy category, 14.44% fell in the low literacy category, 32.47% fell in the medium literacy category, 45.88% fell in the high literacy category, and 5.67% fell in the extremely high literacy category. The frequency distribution for the five categories indicates that 45.88% of the participants

demonstrated high literacy levels for climate change science, with their scores on the assessment range between 61 and 80. With x^2 (4, n = 194) = 132.2, $p < 0.05$; there is no evidence, at 5% significance level, that the frequency distribution is not random. Hence, there is a no significant difference between the expected and the observed score frequencies on climate change science.

Table 4 Inferential analysis of the difference between the score frequencies on climate change science

Total	Level of literacy	Score category	n	%	df	x^2	Yate's x^2	p
	Extremely Low	0-20	3	1.55	4	136	132.2	0.00
	Low	21-40	28	14.44				
Climate change science	Medium	41-60	63	32.47				
	High	61-80	89	45.88				
	Extremely High	81-100	11	5.67				

Discussion

Section 1 of the questionnaire (items 1 to 5) focused on *climate processes and causes of climate change*. With the exception of one item, where only 7% of the participants indicated correctly that water

vapour is the most abundant greenhouse gas and the most important contributor to a natural greenhouse effect, in general, they demonstrated high literacy levels in climate processes and causes of climate change. For this aspect of climate change,

44.85% of the participants scored between 61 and 80, and 29.38% scored between 81 and 100. Only 0.52% scored between 0 and 20, as shown in Table 2. These observations contradict Nwankwo and Unachukwu's (2012) study, which found that teachers are not quite knowledgeable of the causes of climate change. One has to bear in mind, however, that their study did not involve Geography teachers and that the context of the study was different.

The mean for *climate change impacts* was 56.98, with 11.9% of the participants scoring between 0 and 20; 21.65% scoring between 61 and 80; and 29.38% scoring between 81 and 100, as shown in Table 3. These results are a reflection of the participants' performance in Section 2 of the questionnaire, comprising items 6 to 10. The majority of the teachers answered the items in this section correctly, with one exception. A minority (8%) of the participants understood that low incidences of diseases in some countries were not necessarily the result of climate change. The results of this section of the questionnaire largely contradict Vujovic's (2013) research, which showed that only a few Geography teachers in Gauteng Province, South Africa, possess a deep scientific knowledge of the impacts of climate change. Furthermore, the results showed that the mean for *climate change responses* was 55.3, with 4.64% of the participants scoring between 0 and 20; 33.51% scoring between 61 and 80; and 11.34% scoring between 81 and 100, as shown in Tables 1 and 3.

These results are a reflection of the participants' performance in Section 3 of the questionnaire, comprising items 11 to 15. The majority of the teachers answered three of the items in this section correctly. However, only 31% of the participants (the minority) understood correctly that the term 'carbon sequestration' means the removal of CO_2 from the atmosphere and depositing it in reservoirs. Moreover, only 34% of the participants (the minority) responded correctly to the item indicating that implementing guidelines to achieve carbon emission reduction targets is not a community-based adaptation to climate change. Table 1 shows that the mean ($\bar{x}$) for climate change solutions is 55.3, with a minimum score of zero, and maximum score of a hundred. These results indicate that only some of the participants demonstrated high literacy levels on this variable and they corroborate Vujovic's (2013) research, which found that Geography teachers in Gauteng province of South Africa hold both correct and incorrect understandings of appropriate climate change responses. In contrast, Ambusaidi et al. (2012) found that teachers in Oman demonstrated a detailed awareness of the measures humans can take to mitigate and adapt to climate change.

In total, the participants demonstrated a high level of literacy regarding climate change science, as shown in Table 4. The observed score frequency distribution shows that 1.55% of the participants demonstrated extremely low literacy, 14.44% demonstrated low literacy, 32.48% demonstrated medium literacy, 45.88% demonstrated high literacy, and 5.67% demonstrated extremely high literacy. These results contradict studies by Boon (2010), Ekpoh and Ekpoh (2011), Nwankwo and Unachukwu (2012), and Ochieng and Koske (2013), who found that teachers have a medium level of understanding of climate change. However, it needs to be borne in mind that these studies employed different summated scales and were conducted in different contexts. With the Western Cape Province being one of the most socially, economically and educationally advanced provinces in South Africa, the results of this study could provide an insight into the level and dimension of climate change science literacy of Geography teachers in other provinces with similar characteristics as those of the Western Cape, such as Gauteng, North-West and Free State. They also make possible comparative studies in other countries with a similar socio-economic status as that of the Western Cape province, South Africa.

The findings of this study corroborate those of some international studies but are also in conflict with the findings of other international studies. This is understandable, given that contexts differ; but importantly, it also needs to be understood that the body of knowledge on climate change is limited, given the emerging nature of the field – patterns are therefore not easily identifiable. This study adds to a body of international literature still in its infancy, and opens up opportunities for similar studies to be conducted internationally and locally towards patterns of significance being mapped according to larger datasets.

Conclusion

Through this survey it was discovered that the majority of Geography teachers in the Western Cape demonstrated significantly high literacy levels regarding climate change science. They showed higher levels of literacy in climate processes and causes of climate change than in climate change impacts and climate change solutions, but the difference was not statistically significant. However, some gaps in teachers' knowledge of climate change science were evident. The majority of the teachers did not know that water vapour is the most abundant greenhouse gas and also that it is the most important contributor to the natural greenhouse effect in the atmosphere; that climate change science is characterised by a measure of uncertainty; and that incidences of diseases in some developing countries is not solely due to climate change. Furthermore, the majority of the teachers did not know that the term carbon sequestration refers to the removal of CO_2 from the atmosphere

and depositing it in reservoirs; and that implementation of national policies to achieve carbon emission reduction targets is not an example of a community-based adaptation to climate change (see question 12, Appendix A).

The high literacy levels in climate change science demonstrated by Geography teachers in this study are a positive finding for promoting climate change education in the Western Cape. This may be an indication of South Africa's commitment to international responses to tackling global climate change by means of education through Geography teacher education. But given the assertion by Gooding and Metz (2011) that misconceptions are resistant to change once they have been formed, there is concern that the misconceptions of Geography teachers about climate change science could be transferred to the Geography learners and other teachers, who rely on them for information on some of the climate change concepts they teach. Based on the findings of this study, we advise teacher educators and policymakers to consider continuing education interventions that will enable Geography teachers to develop deeper scientific knowledge and understanding of climate change, such that they will be able to promote the development of climate change science literacy in schools. Research is needed to understand the dimension and levels of literacy regarding climate change science among Geography teachers in each education district in the Western Cape and in other provinces in South Africa where empirical studies of this nature have not been conducted. Moreover, given the burgeoning literature on Education for Sustainability in relation to climate change, the nexus between climate change and sustainable development could be explored within Geography Education.

Acknowledgement

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Appendix A: Sample of Items on Climate Change Science Literacy Instrument

Question 2
The term global warming refers to
a.   a high concentration of carbon dioxide in the lower atmosphere
b.   rapid changes in dynamics and processes of the climate system
c.   changes in global climate and local weather patterns
d.   increase in mean temperature of the Earth's atmosphere

Question 8
Most sub-Saharan African countries are highly vulnerable to climate change mainly because of their
a.   low CO_2 emissions per capita
b.   low adaptive capacity
c.   high CO_2 emission per capita
d.   high adaptive capacity

Question 11
The term 'carbon sequestration' means
a.   interruptions of the carbon cycle by human being
b.   the removal of CO_2 from the atmosphere and depositing it in reservoir
c.   flow of CO_2 through the oceans, terrestrial biosphere and lithosphere
d.   production of large quantities of CO_2 from industrial processes

Question 12
One of these is not a community-based adaptation to climate change
a.   initiate projects aimed at poverty eradication
b.   introduce national policies to achieve carbon emissions reduction targets
c.   establish disaster-risk reduction centres in rural areas
d.   encourage local people's participation in natural resource conservation

Question 14
A reduction in economic growth in developing countries due to global warming could cause all, except
a.   out-migration
b.   reduced income opportunities
c.   decrease in outbreak of diseases
d.   poor service delivery