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Investigating Pre-service Science, Technology, and Mathematics Teachers' Attitudes toward Climate Change in Nigeria

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A B S T R A C T

The study investigated attitudes toward climate change among 480 pre-service science, technology, and mathematics (STM) teachers from four higher institutions of learning in Southwest, Nigeria using the quantitative research method within the blueprint of the descriptive survey design. Data collected using climate change attitude survey were analysed using the descriptive statistics of percentages, mean, and standard deviation and inferential statistics of factor analysis and independent samples t-test. Findings revealed that attitudes toward climate change assessed by the climate change attitude survey was a multi-dimensional construct (perceived beliefs component and intentions component). Gender differences in attitudes toward climate change among pre-service STM teachers were not significant even at the subscale level of perceived beliefs and intentions. In addition, the pre-service STM teachers showed a moderate level of attitudes toward climate change. In conclusion, there is need for a concerted effort to protect the earth from increased weather variability and the Nigerian government at all levels has both international and domestic commitments to reduce greenhouse gas emissions to ensuring sustainable human development. Future studies in Nigeria and elsewhere should conduct a confirmatory factor analysis on the climate change attitude survey to further generalise the findings of this study.

1. Introduction

Several years back global climate change was once a naysaying among scientist the world over (Carter, 2013). Today, the vast majority of scientists approve that human activities such as emission of carbon-dioxide into the atmosphere have

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been causing global climate change (Patchen, 2006). Global climate change has been documented as both an environmental issue (Intergovernmental Panel on Climate Change [IPCC], 2007) and as a socially fabricated problem (Williams, 1998). Global climate change includes changed patterns of rainfall, warmer air, intense weather events such as storms and hurricanes and sea temperatures (Dow & Downing, 2006) which may have effects such as water shortages, reduced crop yields leading to food shortage, rising sea levels, droughts, extinction of many plant and animal species, spread of climate-sensitive diseases such as malaria and changes in the nitrogen cycle (National Research Council, 2010; IPCC, 2013; United Nations Framework Convention on Climate Change [UNFCCC]). Climate change has an anthropogenic origin (Flores, 2017) which is modifying the chemical composition of the atmosphere through excessive deforestation and use of fossil fuels, contamination of water bodies, carbon emissions from vehicles, and increasing desertification to give rise to increase in the earth's temperature. The changes in the earth climate may have significant impact on the ecosystems, human societies and biodiversity. Climate change is considered the third most serious problem in the world undermining sustainable human development after poverty, lack of food and drinking water and a global economic downturn (European Commission, 2009). It is anticipated that if the present consumption trends are retained, the earth will be heated up by 3^0C over this century ([IPCC], 2007). Thus, sustainability resourcefulness directed at alleviating human's impact on climate are indispensable and becoming gradually ubiquitous (Hulme, 2009). However, global climate change is difficult to isolate from conversations about energy use because climate change is unswervingly associated to energy sources, energy consumption, and the sustainability of energy systems (IPCC, 2009; Hulme, 2009).

Sustainable energy initiatives should aim at decreasing fossil fuel consumption in order to mitigate global climate change. Mitigation involves a practise of decreasing greenhouse gas emissions from human activities, for instance emissions from fossil fuels as well as deforestation, with the aim of calming greenhouse gas concentration at a harmless level. The World Health Organization (2011) projected that climate change is now accountable for about 150,000 deaths per year; a fresher report by the Climate Vulnerability Monitor valued this number at more than 400,000 annual deaths, along with thousands of dislodgments (Climate Vulnerability Forum, 2012). Environmental inequality, both within and between countries, influences the adaptive capability of people confronted with climate-related disturbances. Global climate change has brought about environmental unequal exchange in which raw natural resources from developing countries are concentrated in the developed countries, while the developing or underdeveloped countries bear the brunt of the environmental effects of mining them. Nigeria as a developing country in Africa is faced with climate change problem. Nigeria in a way is contributing to atmospheric greenhouse gas (GHG) concentration levels causing climate change through gas flaring, carbon emissions from vehicles, and burning of fossil fuels. Since Nigeria has a lower adaptive capacity, it is feeling the damaging impacts of climate change in which the country's coastline in the south is susceptible to sea level rise and desertification in the north. Water shortage in the face of climate change is a source of worry

among Nigerians and the reduction in the quantity and quality of water resources in Nigeria owing to the impacts of climate change makes it important for the country to adapt (Ojomo, Elliott, Amjad & Bartram, 2015). Adaptation is the modification of systems to actual or expected climate and its effects and seeks to diminish the hostile impacts and exploit the valuable opportunities of climate change (IPCC, 2014).

Local perceptions of and attitudes toward climate change are important motivations for climate change research. In Nigeria little is known about attitudes toward climate change. Ojomo, Elliott, Amjad and Bartram (2015) found that while Nigerians believe human activities are a significant cause of climate change, they were less knowledgeable about the effects of climate change on Nigeria as a whole but more aware of impacts relevant to Southern Nigeria where study sites were located. It is important that future decisions makers (students including pre-service teachers) in Nigeria are knowledgeable about climate change and its attendant impacts on the country to promote effective and efficient adaptation and mitigation mechanisms.

Educating students about climate change and human impact on the environment will make them more responsible adults who will make informed decisions regarding the environment in the future (Christensen & Knezek, 2015). It is evident that students who have more favourable attitudes toward the idea of human-induced climate change are more likely to report a willingness to take action (Sinatra, Kardash, Taasoobshirazi, & Lombardi, 2012). Likewise, increasing environmental content knowledge in students produces more positive attitudes and responsible behaviour toward the environment (Bradley, Waliczek, & Zajicek, 1999; McMillan, Wright & Beazley, 2004). However, a study (Dijkstra & Goedhart, 2012) has shown that knowledge about climate change was unrelated to environment-related attitudes. The beliefs people embrace and the settings in which they make decisions can provide the prompts- but also the hurdles- to attaining effective climate action (Leining, 2014). It is important to note that when planning climate change policies and behaviour-change initiatives, it would be vital to comprehend the association between people's actions to decrease greenhouse gas emissions and their beliefs about the effects of climate change, their detachment from climate change effects and their capacity to make a genuine difference through personal action irrespective of gender.

Studies have shown that females have significantly more positive attitudes toward environmental issues and are more disturbed about the environment than males (Davidson & Freudenburg, 1996; Gardos & Dodd, 1995; Leppanen, Haahla, Lensu & Kuitunen, 2012) to the extent that they become actively concerned in the protection of the environment than males (Tosunoglu, 1993). In a study that compared students' and parents' environmental attitudes, Leppanen et al. (2012) found that girls were as affirmative as their parents while boys were conspicuously more deleterious than their parents. It is clear that women as stewards of natural resources are more susceptible to the effects of climate change than men primarily because they make up the majority of the world's poor whose livelihood are more dependent on natural resources that are endangered by climate

change (UN WomenWatch, 2009; UNFCCC; IPCC, 2014). These effects are more devastating for women in rural areas in developing countries who are reliant on local natural resources for their livelihood and are faced with social, economic and political barriers that limit their coping capacity regarding climate change (UN WomenWatch, 2009; UNFCCC; IPCC, 2014). Because women in rural areas have unequal access to resources and are sometimes relegated in decision-making processes, their limited mobility places them in a position in which they are undeservedly affected by climate change (UN WomenWatch, 2009; Patchen, 2006). It is thus, practically imperative, to recognise gender-sensitive approaches and policies to react to the ecological and humanitarian catastrophes triggered by climate change (UN WomenWatch, 2009; Patchen, 2006).

As worrisome as the issue of climate change is, it is pathetic to note that there is paucity of instrument to measure attitudes toward climate change in middle school students (Christensen & Knezek, 2015). Many of the instruments were developed for the adult populations (Leiserowitz, Maibach, Roser-Renouf, Feinberg & Howe, 2013; Milfont & Duckitt, 2010; Sinatra et al., 2012) and concerned general environmental science or energy surveys (DeWaters, Qaqish, Graham, & Powers, 2013; Metin, 2010; Musser & Malkus, 1994) in which some items on the instruments were biased in their wordings (Le Hebel, Montpied, & Fontanieu, 2014). A recent instrument developed by Christensen and Knezek (2015) would be used in this study for measuring attitudes toward climate change among pre-service mathematics teachers in Nigeria. It is important to note that since this instrument was developed in the US, it will be appropriate to determine its factorial structure in a new setting like Nigeria because of cross-cultural differences between the US and the Nigerian populace. More so, the pre-service mathematics teachers in the present study are more matured in terms of knowledge and older than the middle school students sampled in the previous study.

Studies on pre-service teachers' conceptions of climate change showed that pre-service teachers held misconceptions and misunderstandings about climate change (Boon, 2010; Summers, Kruger, Childs, & Mant, 2000; Lambert, Lindgren, & Bleicher, 2012) and that they are unaware of appropriate mitigation actions for climate change (Papadimitriou, 2004). More so, pre-service teachers' positive attitudes towards, or self-reported familiarity with, topics like climate change did not correlate with their scientific knowledge (Boon, 2011). These findings indicate that pre-service teachers have limited knowledge of or no exposure to climate change science at tertiary level or instead have inadequate understanding of climate change. In a study conducted by Boon (2016) with 87 pre-service teachers on attitudes to environmental education and knowledge of climate change, found that pre-service teachers' attitudes towards environmental education were consistently favourable, but their climate change science knowledge had not changed as a result of their participation in their degree. It is evident that aside the family, teachers are impeccable socializers of students' pro-environmental behaviour (Duarte, Escario, & Sanagustín, 2015). Thus, it is paramount that teachers are empowered with cognate information to make informed decisions regarding the environment and other socio-scientific issues

that may threaten the students. It has been found that there exists obvious association between pre-service teachers' knowledge, the implemented classroom pedagogy and the students' pro-environmental attitudes and behaviours (Skamp, Boyes & Stanisstreet 2013). This association showed that teachers as agents of change need to attain sustainable development (UNESCO, 2010), and thus teacher education programmes must give teachers a voice in creating a sustainably dependable future (Shephard, 2008) that will mitigate climate change.

Teacher education has been identified as a key to nation building. Often times it is said "train the teachers, build the nation" (Fatade, Nneji, Awofala, & Awofala, 2012, p.105). Conventional universities in Nigeria are saddled with the responsibility of training the teachers who in turn train the students at the primary and secondary school levels. Of all the teacher education programmes mounted by Nigerian universities, degrees in science, technology and mathematics education courses are often sort after by prospective undergraduates (Fatade etal, 2012). This is not unconnected to the status of science, technology, and mathematics in school curriculum and the recognition given to science education in general as contained in section seven number 39 (d) in the National Policy on Education (FRN, 2004). The policy stipulates that "government shall popularize the study of the sciences and the production of adequate number of scientists to inspire and support national development' (p. 29).

This study focussed on pre-service science, technology, mathematics teachers' education for climate change because as noted by Boon (2016), pre-service teacher education helps to get ready and empower imminent citizens such as school children to enact mitigation and adaptation actions in respect of climate change. In Nigeria, science, technology, and mathematics are not only regarded as general subjects for STM related disciplines at the university level but a cross-cutting core compulsory subject for students who opt for science, technology, engineering, and mathematics (STEM) at the university level (Awofala, 2012; Awofala, Ola-Oluwa & Fatade, 2012) which can be supplemented with education for sustainability and climate change science to reach out to young minds on ways to mitigate these socio-scientific topics. Integrating climate change science into STEM teaching at both the school and the pre-service teacher levels may not be considered odd given the request that 'all levels and forms of existing educational and teaching and learning programmes need to be reviewed and re-orientated to address the causes and consequences of climate change' (UNESCO 2009, para. 1). Undoubtedly, this has brought about a concentration on sustainability and teacher education globally (UNESCO 2009; Boon, 2016). Pre-service STM teachers' understanding and awareness of climate change is however an issue that warrants thoughtfulness, since it is a pre-requisite for creating and engendering pedagogically all-encompassing learning proficiencies for students (Boon, 2016).

The objectives of this study are three folds: (1) to determine the factor structure of the Climate Change Attitude Survey among Nigerian pre-service STM teachers; (2) to investigate the level of attitudes toward climate change among Nigerian pre-service STM teachers; and (3) to assess the influence of pre-service STM teachers' gender on attitudes toward climate change in Nigeria.

Research Questions

RQ1. What is the factor structure of the Climate Change Attitude Survey among Nigerian pre-service STM teachers?
RQ2. What is the level of attitudes toward climate change among Nigerian pre-service STM teachers?
RQ3. Is gender a factor in attitudes toward climate change among Nigerian pre-service STM teachers?

2. Methodology

The study made use of quantitative research method within the blueprint of the descriptive survey design. The participants in this study were 480 senior pre-service STM teachers (250 males and 230 females) from 4 Universities in Southwest Nigeria. Their age ranged from 19 to 28 years with mean age of 21.5 years and SD=1.6 years. The senior pre-service STM teachers were from Biology Education, Chemistry Education, Integrated Science Education, Mathematics Education, Physics Education, and Technology Education disciplines of study. Table 1 below showed the demographic profile of the participants.

Table 1. Demographic data of the participants

Discipline of Study	**f**	**(%)**	**male (%)**	**female (%)**
Biology Education (16.52)	80	(25)	42 (16.8)	38
$Mean_{age}$=20.4 years	SD=1.3 years		Age range=19-26 years	
Chemistry Education (16.52)	80	(25)	42 (16.8)	38
$Mean_{age}$ = 21.7 years	SD = 1.8 years		Age range= 19-28 years	
Integrated Sc. Education	80	(25)	42 (16.8)	38 (16.52)
$Mean_{age}$ = 22.3 years	SD = 1.7 years		Age range= 19-27 years	
Mathematics Education	80	(25)	42 (16.8)	38 (16.52)
$Mean_{age}$ = 21.3 years, SD = 1.9 years			Age range= 19-28 years	
Physics Education (16.96)	80	(25)	41 (16.4)	39
$Mean_{age}$ = 21.3 years, SD = 1.9 years			Age range= 19-27 years	
Technology Education	80	(25)	41 (16.4)	39 (16.96)
$Mean_{age}$ = 21.8 years, SD = 1.9 years			Age range= 19-28 years	
Age distribution	**f**	**(%)**		
Below 20 years	247	(51.46)		
20-28 years	233	(48.54)		

For the purpose of data collection, one instrument tagged Climate Change Attitude Survey (CCAS) adopted from Christensen and Knezek (2015) was used to collect primary data relating to beliefs and intentions toward the environment with focus on climate change. The CCAS consisted of 15 items anchored on a 5-point Likert scale ranging from: Strongly agree -5, Agree -4, Undecided -3, Disagree -2, to Strongly disagree -1. The internal consistency reliability coefficient of the CCAS was computed using the Cronbach alpha (α) with value of 0.72 (Christensen & Knezek, 2015). The authors together with four research

assistants administered the CCAS to the whole sample and in a regularly scheduled class twice within an interval of two weeks. The participants were told that their participation was voluntary and that their responses would be treated with utmost confidentiality. Data collected were summarized and analysed using frequency count, mean, standard deviation, independent samples t-test, and exploratory factor analysis.

3. Results and Discussion

The figure 1 below is the activity of the research and can serve as cover figure in the web of JES.

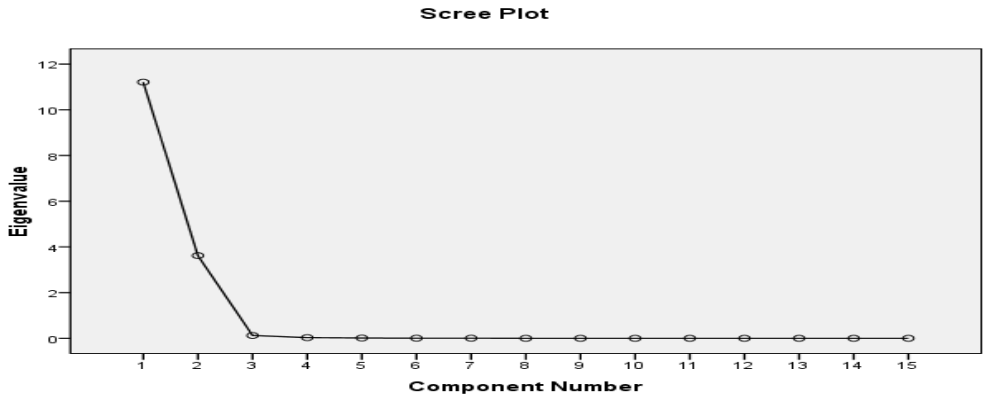

Figure. 1. Cattell scree plot showing number of components and eigenvalues of the correlation matrix

Research Questions One: What is the factor structure of the climate change attitude survey among Nigerian pre-service STM teachers?

For research question 1, the responses of the participants to the 15 items of climate change attitude survey were subjected to principal components factor analyses (PCA) to identify their underlying dimensions. The data screening processes were carried out and showed no missing values for the 480 participants. Subsequently, further screening showed no concern about normality, linearity, multicollinearity, and singularity. For example, scale scores were normally distributed with skewness and kurtosis values within acceptable ranges (Table 2) as Kline (1998) suggested using absolute cut-off values of 3.0 for skewness and 8.0 for kurtosis.

Table 2. Skewness, kurtosis and measure of sampling adequacy

	Minimum	Maximum
Skewness	-.597	-.314
Kurtosis	-.810	-.530
MSA	.803	.912
Bartlett's test of sphericity, $\chi 2 = 3246.06; df=340; p<.001$		
The Kaiser-Meyer-Olkin measure of sampling adequacy (MSA) = .805		

Thus, most of the partial correlations were small as indicated by the anti-image correlation matrix. These measures all led to the conclusion that the set of 15 items of climate change attitude survey was appropriate for PCA and since no particular number of components was first hypothesized, the criterion was set to eigenvalues greater than one (Kaiser, 1960; Tabachnick & Fidell, 2007). The initial unrotated PCA resulted in a factor model of two dimensions as indicated by the eigenvalues exceeding unity while the scree plot also showed a factor model of two dimensions. However, based on its pattern of factor loadings, this unrotated factor model was theoretically less meaningful and as such was difficult to interpret. Therefore, the analysis proceeded to rotate the factor matrix orthogonally using varimax rotation with Kaiser Normalisation to achieve a simple and theoretically more meaningful solution. The rotation resulted in a factor model of two dimensions as suggested by the scree plot and eigenvalues exceeding unity.

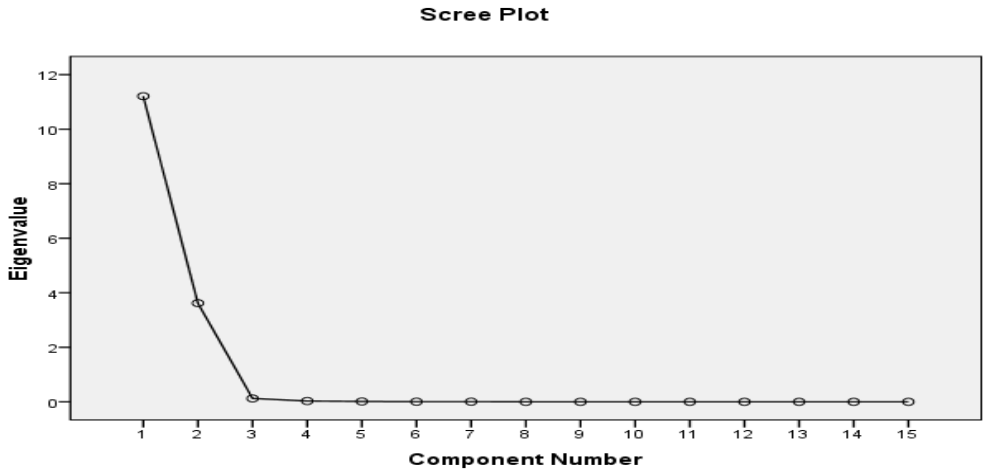

Figure. 1. Cattell scree plot showing number of components and eigenvalues of the correlation matrix

Table 3. Mean and standard deviation and summary of factor loadings by principal components analysis for the orthogonal two factor model

	A. Perceived beliefs					Factor	
Factor 1	**SA/A**	**SD/D**	**U**	**Mean**	**St.D**	**Loading**	**h^2**
1. I believe our climate is changing.	221(46)	120 (25)	139 (29)	3.17	1.18	.964	.970
2. I am concerned about global climate change.	221(46)	120 (25)	139 (29)	3.18	1.16	.974	.992

3. I believe there is evidence of global climate change.	221(46)	125 (26)	134 (27.9)	3.19	1.16	.977	.999
4.Global climate change will impact our environment in the next 10 years.	226 (47.1)	120 (25)	134 (27.9)	3.21	1.17	.961	.969
5. Global climate change will impact future generations.	223 (46.4)	120 (25)	137 (28.5)	3.19	1.17	.969	.984
6. The actions of individuals can make a positive difference in global climate change.	222 (46.2)	122 (25.4)	136 (28.3)	3.19	1.16	.974	.994
7. Human activities cause global climate change.	226 (47.1)	120 (25)	134 (27.9)	3.20	1.16	.973	.991
8. Climate change has a negative effect on our lives.	226 (47.1)	120 (25)	134 (27.9)	3.21	1.17	.965	.976
9. We cannot do anything to stop global climate change	136 (28.3)	122 (25.4)	222 (46.2)	3.19	1.16	.975	.992
10. I can do my part to make the world a better place for future generations.	222 (46.2)	122 (25.4)	136 (28.3)	3.19	1.16	.974	.994
Sub-total				3.19	1.16		
B. Intentions							
Factor 2							
11. Knowing about environmental problems and issues is important to me.	293 (61.1)	91 (19)	96 (20)	3.59	1.16	.974	.997
12. I think most of the concerns about environmental problems have been exaggerated*.	97 (20.2)	91 (19)	292 (60.9)	3.59	1.16	.976	.998
13. Things I do have no effect on the quality of the Environment	98 (20.4)	92 (19.2)	290 (60.5)	3.59	1.17	.972	.990
14. It is a waste of time to work to solve environmental Problems*.	97 (20.2)	90 (18.8)	293 (61.1)	3.58	1.17	.974	.994
15. There is not much I can do that will help solve environmental problems*.	96 (20)	92 (19.2)	292 (60.9)	3.59	1.17	.972	.989
Sub Total				3.59	1.17		
Total				3.59	1.17		

*Item for which scoring is reversed. Low Level: 1.00-2.99; Moderate Level: 3.00-3.49; High Level: 3.50-5.00

In this study, all the communalities (h^2) for the factor analysis satisfied the minimum requirement of being larger than 0.50, in fact these ranged from 0.969 to 0.999. Figure 1 above is the scree plot which graphs the eigenvalue against the component number and is suggestive of a two component model.

Table 3 displayed the factor loadings for the orthogonal two-factor model of climate change attitude survey. All items loaded .961 and above on their primary factor; none of the secondary loadings exceeded .30. Together the two factors accounted for 98.86% of the total variance. The first factor accounted for 74.73% of the variance (eigenvalue= 11.21) and consisted of 10 perceived beliefs component items. The second factor accounted for 24.13% of the variance (eigenvalue = 3.62) and consisted of five intentions component items. The internal consistency reliabilities for the subscales are: perceived beliefs (α = .99) and intentions component (α = .99) and the internal consistency reliability for the entire survey (α =.97) was considered very high and conceptually meaningful (Curtis & Singh, 1997; Awofala & Anyikwa, 2014). Thus, the two measures represent empirically separable and internally consistent climate change attitude constructs. Since the climate change attitude survey separated into 2 latent factors identified to possess minimum of 1.0 eigenvalues, statistically significantly reliable and non-overlapping subscales based on these 2 factors could be used in any subsequent data analyses. The following models were obtained:

$F_1=0.96a_{11}+0.97a_{12}+0.98a_{13}+0.96a_{14}+0.97a_{15}+0.97a_{16}+0.97a_{17}+0.97a_{18}+0.98a_{19}+0.97a_{1n}$

$F_2=0.97a_{21}+0.98a_{22}+0.97a_{23}+0.97a_{24}+0.97a_{25}$

Where aij are the items that loaded significantly high on factor i, i and j are unique for each model because no item indicates a factorial complexity of two or more. The two weeks test- retest reliabilities of .92, .93, and .90 for the perceived beliefs, intentions, and entire survey were computed, respectively. The two subscales showed acceptable internal consistency reliability and test-retest reliability.

Research Question Two: What is the level of attitudes toward climate change among Nigerian pre-service STM teachers?

Table 3, showed the overall attitudes toward climate change among Nigerian pre-service STM teachers. The actual numbers and percentages for responses to each statement were shown in the table. The percentages were in parenthesis. Table 3 showed that the pre-service STM teachers in the present study had moderate level of attitudes toward climate change (Mean=3.39, SD= 1.17). In relation to the perceived beliefs (Mean=3.19, SD=1.16), 46% agreed/strongly agreed that: I believe our climate is changing (item 1), 46% agreed/strongly agreed that: I am concerned about global climate change (item 2), 46% agreed/strongly agreed that: I believe there is evidence of global climate change (item 3), 47.1% agreed/strongly agreed that: Global climate change will impact our environment in the next 10 years (item 4), 46.4% agreed/strongly agreed that: Global climate change will impact future generations (item 5), 46.2% agreed/strongly agreed that:

The actions of individuals can make a positive difference in global climate change (item 6), 47.1% agreed/strongly agreed that: Human activities cause global climate change (item 7), 47.1% agreed/strongly agreed that: Climate change has a negative effect on our lives (item 8), 46.2% disagreed/strongly disagreed that: We cannot do anything to stop global climate change (item 9), 46.2% agreed/strongly agreed that: I can do my part to make the world a better place for future generations (item 10). In relation to intentions (Mean=3.59, SD=1.17), 61.1% agreed/strongly agreed that: Knowing about environmental problems and issues is important to me (item 11), 60.9% disagreed/strongly disagreed: that: I think most of the concerns about environmental problems have been exaggerated (item 12), 60.5% disagreed/strongly disagreed that: Things I do have no effect on the quality of the environment (item 13), 61.1% disagreed/strongly disagreed that: It is a waste of time to work to solve environmental problems (item 14), 60.9% disagree/strongly disagreed that: There is not much I can do that will help solve environmental problems (item 15).

Research Question Three: Is gender a factor in attitudes toward climate change among Nigerian pre-service STM teachers?

Table 4 below showed the descriptive statistics of mean and standard deviation and t-test values on climate change attitude scores by male and female pre-service STM teachers. Table 4 below showed that the pre-service STM teacher female group recorded slightly lower mean score (M=32.31, SD=11.01) in perceived beliefs component than their male counterparts (M=32.36, SD=10.93) and this difference was statistically not significant (t_{478}=0.04, p=.97). With respect to intentions component, the pre-service STM teacher female group recorded slightly higher mean score (M=17.56, SD=5.23) than their male counterparts (M=17.51, SD=5.28). However, this difference in mean score was statistically not significant (t_{478}=-0.10, p=.92). With respect to aggregate climate change attitude, the pre-service STM teacher female group recorded slightly higher mean score (M=48.67, SD=6.05) than their male counterparts (M=48.49, SD=6.16). However, this difference in mean score was statistically not significant (t_{478}=-0.31, p=.76). Thus, it is concluded that gender was not a factor in pre-service STM teachers' attitudes toward climate change even at the subscale level of perceived beliefs and intentions.

Table 4. Independent samples t-test analysis of pre-service STM teachers' climate change attitude according to gender.

	Gender N	M	SD	Df	t	p
Perceived beliefs	Male	250	32.36	10.93	478	.04.97
	Female	230	32.31	11.01		
Intentions	Male	250	17.51	5.28	478	-.10.92
	Female	230	17.56	5.23		
Climate Change Attitude	Male	250	48.49	6.16	478	-.31.76
	Female	230	48.67	6.05		

Discussion

The results of the present study have shown three main findings. These findings relate to establishing the factor structure of the climate change attitude survey with pre-service STM teachers; determining the level of attitudes toward climate change of pre-service STM teachers; and determining whether differences existed between male and female pre-service STM teachers in attitudes toward climate change.

The result of the present study showed that attitudes toward climate change as measured by the climate change attitude survey is a multi-dimensional construct. The exploratory factor analysis using the principal components analysis showed a two factor structure underlying the survey. The two interpretable factor structures are subsequently labelled: perceived beliefs component (with 10 items) and intentions component (with 5 items) and each subscale had adequate internal consistency reliability. This is in line with the finding of Christensen and Knezek (2015) which empirically revealed the multi-dimensional nature of the climate change attitude survey. In the present study, two methods of determining a measure's internal reliability have been adopted: Cronbach alpha reliability coefficient and test-retest reliability coefficient (Awofala & Akinoso, 2017). In this study, coefficient alphas and coefficients of congruence were generally strong. Each of the sub-scale was subsequently examined for internal reliability and was found to have met the criteria of 0.70 as recommended by Nunnally and Bernstein (1994). Items for each of the sub-scale were again examined for construct validation by employing item to total score correlations. Each of the items in the two sub-scales was found to correlate very significantly at {$p<.01$} with the total score for that sub-scale. The correlation coefficients for each of the item in the respective sub-scales reflect the factor loading coefficients that were yielded as a result of running a principal component exploratory factor analysis. The good internal consistency reliabilities obtained here (and in other studies) suggest that the instrument would be found quite useful for educators in ascertaining the attitudes toward climate change of their students most of whom are pre-service teachers.

In the present study, the pre-service mathematics teachers showed a moderate level of attitudes toward climate change (Mean=3.39, SD=1.17). The moderate level of attitudes toward climate change among the pre-service STM teachers is suggestive of the fact that attitude change could be attained by featuring climate change in the pre-service teachers' curriculum (Boon, 2010; Boon, 2016) and by providing the impetus for scientists to participate in public debate on climate change (Patchen, 2006) in Nigeria. Human-induced climate change as complex socio-scientific issues are likely to be met with stiff opposition on the part of some pre-service teachers and other students alike. That the topic of human-induced climate change is theoretically challenging and some students may perceive it as controversial (Patchen, 2006; Boon, 2016) underscores the finding of moderate level of attitude recorded in this study and this may present a unique task for engrossing and engaging students prolifically with the content. The attitude of the pre-service mathematics teachers to climate change can be regarded as both

positive and negative and this shows its relation to the processes of societal response to climate change in Nigeria. Thus, campaign on climate change in Nigeria would be effective if the physiognomies of every subgroup are taken into consideration and the sensitization and advocacy strategies are linked to the subgroup's explicit desires since according to Bråten, Strømsø and Salmerón (2011) the least informed students are cynical about their teachers to be an author of reliable information regarding climate change.

The results shown in Table 4 indicated that gender was not a factor in pre-service STM teachers' attitudes toward climate change. The male and female pre-service teachers recorded comparable mean scores in attitudes toward climate change and its dimensions. Thus, gender differences in attitude toward climate change as shown in this study were not significant. This result disagreed with the results of previous studies (Davidson & Freudenburg, 1996; Gardos & Dodd, 1995; Leppanen, Haahla, Lensu & Kuitunen, 2012) which showed that females had significantly more positive attitudes toward environmental issues and are more disturbed about the environment than the males. However, this finding partially supported the work of Christensen and Knezek (2015) which suggested a non-significant difference in beliefs about climate change by gender but significant gender difference in intentions about climate change. Skalík (2015) conducted a study on climate change awareness and attitudes among adolescents in the Czech Republic and found that females were on average no better informed about the climate change; however, they expressed a higher level of personal responsibility than males. Empirical investigations carried out in both the U.S. and the Europe generally show that women are somewhat more likely than men to display and engage in pro-environmental behaviour, such as choosing a car with good gas mileage or participating in a green electricity programme (Zelezny, Chua, & Aldrich, 2000). This gender disparity ensues even though men tend to be better informed about environmental and climate change problems. Nevertheless, men appear to see the imports and dangers of environmental problems generally and climate change in particular as less serious than do women and are less concerned about the hazards (Slovic, 1999). In short, these findings may show the higher primacy that women, as compared to men, have given to humane values (Stern, Dietz, & Kalof, 1993). This may be because, men compared to women have greater forbearance for danger and may place higher premium on utilitarian, compared to moral goals. However, that men incline to display less environmental concern than women in their personal behaviours does not certainly mean that they are less likely to support pro-environmental social policies. O'Connor, Bord, and Fisher (1999) found that U.S. men were slightly more probable than women to back policies (such as various energy-related taxes) projected to diminish global climate change. Even though men tend to be less anxious about climate change compared to women, they appear to make out the intelligence of societal policies to tackle the problem.

Implications

The findings of this study have shown that climate change should be taught to pre-service STM teachers so that they can in turn empower primary and secondary

school students to partake in future adaptation by providing them with knowledge and attitude that would enable them cope disparagingly and innovatively with climate change to accomplish what the current generation seems incompetent of attaining in a well-timed way. At present in Nigeria, climate change is yet to be included in pre-service teachers' curriculum and as such this concept appears to be elusive to them. Pre-service teachers need to be skilful in practical activities that showcase climate change, be cognisant of shared unconventional conceptions that utilise resources and skills to mitigate climate change. Prospective and practicing STM teachers need to comprehend the disparity between correct scientific cynicism and repudiation of climate change. Thus, to help pre-service STM teachers understand and teach about climate change, they must be able to construct their own knowledge of climate change in which their expectations, beliefs, and prior knowledge of climate change are connected. At the university level, climate change as a socio-scientific and emotive issue has the prospect of being used as a dependable context for teaching education for sustainability to pre-service teachers. For pre-service teachers to effectively and creatively cope with climate change and teach it to their students they must be provided with a balanced view of climate change science at the tertiary level. This is because climate change science has been a highly politicized and misrepresented theme in the media and it is only by connecting STM education to environmental education that inconsistencies and doubts raised in scientific debates about sustainability and climate change can be resolved.

4. Conclusion

There is need for a concerted effort to protect the earth from increased weather variability. The Nigerian government at all levels has both international and domestic commitments to reduce greenhouse gas emissions to ensuring sustainable human development. The efforts of the Nigerian government should centre on: decreasing women's helplessness, in relation to men's vulnerabilities; endorsing gender sensitive crisis responses; and recruiting women as key extenuators and adaptors in natural catastrophe administration decision-making processes, together with men, gaining from women's skills, inventiveness and direction in mitigation and adaptation efforts.

One limitation of the study is in the area of the instrument used for data collection. Though highly useful, survey as an instrument cannot arrest the nuance of social milieu and sense of place which researchers have established affect people's understanding of climate change. Based on this it is suggested that future researches should adopt ethnographic approach in dealing with the issues of climate change since this approach can add meaningfully to the nuance lacking in larger-scale survey method. In conclusion, future studies in Nigeria and elsewhere should conduct a confirmatory factor analysis on the climate change attitude survey to further generalise the findings of this study.

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