AWARENESS OF CLIMATE VARIABILITY AND CHANGE AMONG UNDERGRADUATE STUDENTS OF KENYATTA UNIVERSITY, KENYA

ABSTRACT

Climate change is an intergenerational challenge likely to impede the realization of Sustainable Development Goals. To combat the effects of climate change requires public understanding of the science behind climate change. Studies however show that the levels of awareness are still low across the world especially in Africa where vulnerability to the effects of climate change is on the rise. There's a need therefore for public education to enhance awareness on the subject, since awareness is a key to effective climate action. This study sought to research on awareness levels of climate variability and change among undergraduate students of Kenyatta University, in Kenya. The objective was to find out how students' knowledge and awareness of climate change vary with study discipline and level of study and how these variables influence participation in mitigation and adaptation strategies. A quasi- experimental research design was adopted in which units on environmental education and climate change were considered the treatment variable. Using stratified random sampling, a sample size of 375 students (n=375) were drawn from three schools. School of Agriculture and Environmental Sciences formed the experimental group, given the exposure to the treatment variable while School of Business and School of Humanities and Social Sciences formed the control group. A questionnaire was administered to participants drawn from each year level within the three schools. Analysis was done using Kruskal Wallis one-way ANOVA. The results revealed a statistically significant difference in the medians of climate change knowledge level across the categories of schools, $\chi^2(2) = 41.138$, $p<0.05$. A significant difference exists in the distribution of climate change knowledge across the schools $\chi^2(3) = 17.968$, $p<0.05$. School of Agriculture and Environmental Sciences exhibited a significantly high level of awareness. The three groups were statistically different from each other. Consequently, the null hypothesis of no significant difference in students' awareness of climate change across disciplines 'was rejected. Therefore, there's need to review the university curriculum to incorporate climate change content across disciplines and levels of study to raise awareness levels and enhance capacity. This will essentially equip graduates with necessary knowledge and skills to participate in climate change advocacy programs and cascade the knowledge to the general public for action.

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1.INTRODUCTION

Climate change is one of the greatest ecological and social challenge of the twenty first century (Dietz *et.al*., 2020). There is a general agreement among the scientific fraternity that there exists a correlation between global warming and anthropogenic activities (Cook.*et. al*., 2013; Leiserowitz*et. al.*, 2018). There is a proof that climate change is a natural occurrence, exacerbated by human influence (Houghton *et.al*., 2001; Leiserowitz*et. al.,* 2018). Uncontrolled human activities have led to environmental degradation and a rise in atmospheric concentration of greenhouse gases from emissions, thus causing global warming and subsequently climate change (IPCC, 2007). Such uncontrolled human influences will cause far-reaching impacts that will threaten many aspects of life on earth (Hinkel*et al*., 2014; Seneviratne*et. al*., 2012). Responses to climate change will fundamentally reshape various phenomena, interactions and relationships (Howard-Grenville *et.al*., 2014).

The deleterious effects of climate change which cannot be overlooked include~~;~~ rising temperatures, rising sea levels resulting from melting glaciers, increase in disease outbreaks, increase in frequency of floods and heat waves in different parts of the world (Madrigano*et. al.*, 2018; Rekha*et.al.,* 2019). Consequently, global health will be threatened by the changing climate, which is one of the causes of high morbidity and mortality rate from extremeweather events (Madrigano*et.al.,* 2018). Rising temperatures and increas~~ed~~ing harmful radiations for instance, are the major cause of heat related diseases such as heat stroke, skin cancer and diarrhea (Orimoloye*et.al.*,2019). Some impacts of climate change directly affect the mental health and well-being of an individual.For instance, climate events such as wildfires, hurricanes, and droughts can cause trauma~~.~~ (Atwoli*et. al.,* 2022).

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The veracity of natural environment and biodiversity are being threatened by climate change, yet there exist great disparities in public awareness on the issue (Lee *et. al.*,2015). In Africa, climate change effects are progressively disrupting the social and economic structures that the greater population relies on for good health and economic stability (Atwoli*et. al*., 2022). The effects will be detrimental to many sectors in the country's economy such as the agricultural sector, health sector, tourism sector, educationsector and even to thegreater globaleconomy.

Episodes of climate change manifested by extreme weather events are already being experienced in Kenya, affecting food production and consequently threatening food security especially to the vulnerable communities living in the arid and semi-arid areas. Thus, the effects will alter crop patterns and yields in several regions. (Kogo*et.al.,* 2021).

Climate change has generated controversial beliefs among different people to the extent that perception, awareness and knowledge on the causal factors vary widely (Hartter*et.al.,* 2018). Studies point towards an increasing skepticism in the first world countries, supported by socio-political and economic factors while in other regions of the world, there is a developing interest in climate change (Capstick*et. al.,* 2015).

Awareness levels are still low worldwide; more so in developing countries despite the fact that they are more susceptible to climate change effects, given their economic and political challenges (Leiserowitz*et.al*., 2018). It is anticipated that the changing climate could negatively affect the realization of sustainable development of many developing countries. Studies show that people in Africa are more

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knowledgeable about the varying weather patterns but they are less informed about climate change and the impacts. (Taderera, 2010).

2.METHODOLOGY

2.1 Study Area

This study was carried out in Kenyatta University main campus located approximately 18km by road North East of Nairobi Central Business District (CBD) off Nairobi-Thika road. Kenyatta University was selected as a preferable Study Area because of accessibility. Kenyatta University is the second oldest university in Kenya with approximately nine-teen schools offering diverse programmes at Certificate & Diploma, Undergraduate, Masters and Ph.D. Level. Kenyatta University has over 70,000 students enrolled in undergraduate and postgraduate courses and approximately 23,800 undergraduate students on different programs. The university actively participates in environmental management and conservation activities within the university and even outside.

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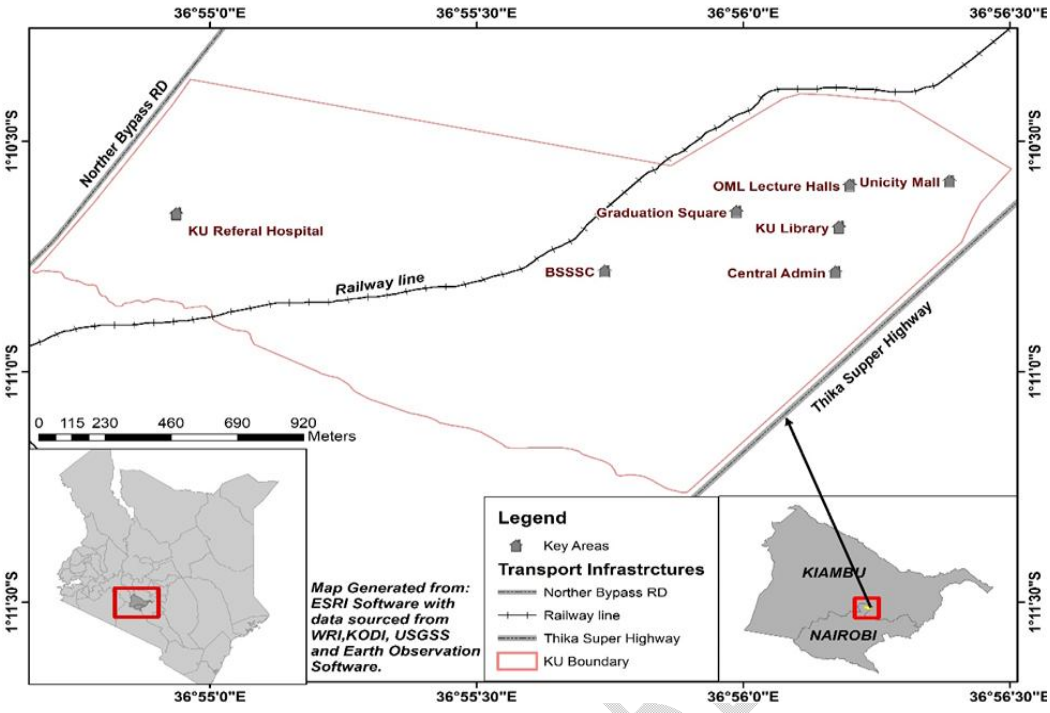

Figure 1. Study Area map (Source; Author, 2023)

2.2 Research Design

The study adopted a quasi-experimental design which is applied in situations where a true experiment cannot be conducted for ethical or practical reasons. (Campbell& Stanley, 1966; Gribbons& Herman, 1997). In a quasi-experimental design, manipulation of the independent variable is not possible because it occurs naturally, and participants cannot be randomly assigned to groups. Any significant difference amongst the groups being studied arise from the treatment administered and not confounding variables. (Campbell & Stanley, 1966; Miller *et.al.*, 2020).

This study used a quasi-experimental design with non-equivalent groups, where three Schools, were purposively sampled for the study. Respondents from Kenyatta University School of Agriculture and Environmental Sciences (KU-SAES) formed the

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experimental group while the control group constituted respondents from Kenyatta University School of Humanities and Social Sciences (KU-SHSS) and Kenyatta University School of Business (KU-SB) with the assumption that, the experimental group (KU-SAES) has already been subjected to a treatment variable, in this case, course content in environmental education and climate change while the control group (KU-SB and KU-SHSS) have not received the same treatment.

2.3 Target population

Kenyatta University has an approximated population of 23,800 undergraduate students on different programs. According to the information provided through oral interview by the administration of the three selected schools, the total number of students enrolled in the three sampled schools is estimated to be 4820 students, distributed as follows: 2822 students enrolled in KU-SHSS, 1200 in KU-SB and 800 are in the KU-SAES. The target population for the study therefore is 4820 students from the three selected schools in Kenyatta University.

Table 1. Target population

YR LEVEL / SCHOOL	Y1	Y2	Y3	Y4	TOTAL
SAES	120	220	200	260	**800**
SHSS	510	800	604	906	**2822**
SB	220	250	350	380	**1200**
TOTAL	850	1270	1154	1546	**4820**

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2.4 Sampling and the sample size

Three schools, KU-SAES, KU-SHSS and KU-SB were purposively sampled. A stratified random sampling technique was then used to select respondents from each year level. Using (Yamane, 1967) formula, the representative sample(n) from the total number of students in KU-SAES, KU-SHSS and KU-SB was obtained and denoted n1, n2 and n3 respectively as shown in the table below. From the list of units offered to each level (referred to as treatment t level) in the semester in each school, one core unit was randomly selected from each level (t1=100 level, t2=200 level, t3=300, t4=400). School and University Common Units, (UCU) were purposively sampled as they provided a suitable forum for the administration of the questionnaires. All students in level 100 in the three schools responded to the questionnaire during UCU 100 lecture. UCU 100 is a common unit in the university for all students in first year in all schools. For the rest of the levels, questionnaires were administered to them when they had a core unit within their respective schools. From level 200, the number of units drawn for the study were one per level in each school by (t2-t4) units to make nine units. In total, ten units were sampled in the three schools. The sample size in each school was then divided proportionally according to the number of students in each year level**. The** formula below was used to determine the sample size;

$$n = \frac{N}{1 + N(e)^2}$$

Where n is the sample size, N is the population size, e is the level of precision (Yamane, 1967). Thus, the sample size for this study was determined as follows

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$$n = \frac{4820}{1+4820(0.05)^2}$$

n=369

2.5 Data Collection Instrument

Data was collected using a questionnaire, constructed from the objectives of Environmental Education to test students' knowledge and awareness level of climate change, attitude towards the subject matter and their participation in mitigation and adaptation measures**.**

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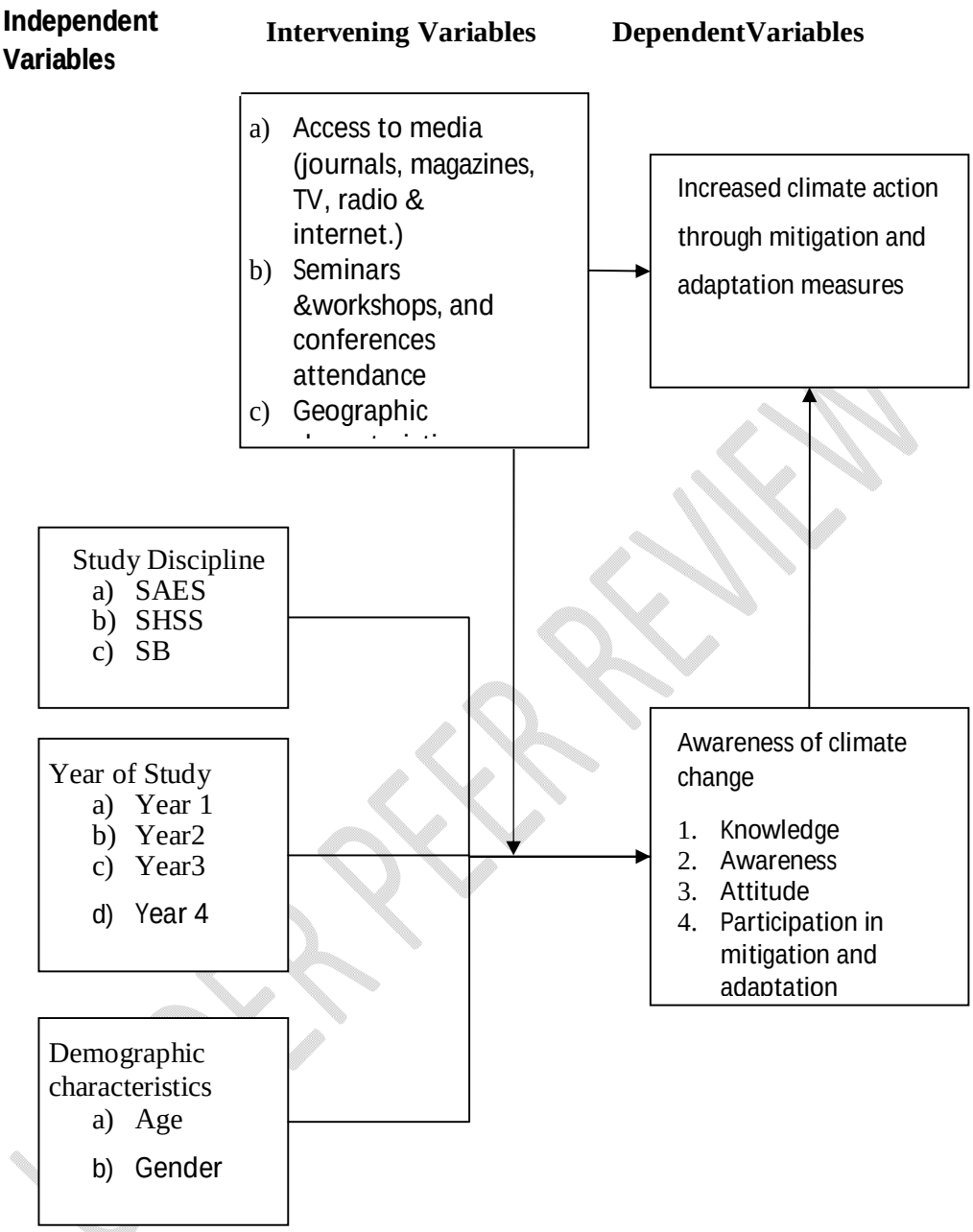

Figure 2. Conceptual Framework

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3.0 RESULTS AND DISCUSSION

3.1 Demographic information

Demographics included gender, age, school and level of study of the respondents, as well as their main and popular source of climate change information. The response rate was at 95.4%

3.2 Gender of the respondents

The study involved a total of 375 respondents (n=375) 198 males and 177 females. The response rate was at 52.8% for males and 47.2% for females. Generally, more males showed interest to participate in the study than females. The statistics are as shown in the table

Table 2. Participation by gender

	n	%
Male	198	52.8
Female	177	47.2
Total	375	100

3.3 Schools

The study involved respondents from three sampled schools across the year levels. The response rate was 54.7% for SHSS (n= 205), 26.4% for SB (n=99) and 18.9% for SAES (n=71) as shown in the table below

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Table 3. Respondents' School

	n	%
SAES	71	18.9
SB	99	26.4
SHSS	205	54.7
Total	375	100

3.4 Year of Study

Generally, there was a higher response rate among the fourth year students and second year students across the three schools (n=134), 35.7% and (n=98), 26.1% respectively, compared to the 1st and 3rd years who were a bit more reluctant.

Table 4. Participation by level of study

	n	%
Year 1	67	17.9
Year 2	98	26.1
Year 3	76	20.3
Year 4	134	35.7
Total	**375**	**100**

3.5 Age of the Respondents

All respondents were between the age of 18 and 26 years with majority falling between the age of 22-23 years (n=138). This is the age group for majority of students who enroll for undergraduate programs in Public Universities in Kenya.

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Table 5. Participation by age

Age Category	n	%
18 - 19 years	42	11.2
20 - 21 years	134	35.7
22 - 23 year	138	36.8
24 years and above	61	16.3
Total	**375**	**100.0**

3.6 Knowledge of Environmental Bodies

Students' knowledge of selected environmental bodies was measured using a 5- item Likert Scale where (1- No knowledge, 5- Excellent knowledge). A significant number of students indicated that they had little or average knowledge in environmental bodies such as IPCC (n=109, 29.1%), REDD+(n=123, 32.8%), Kyoto Protocol (n=116, 30.9%) and UNFCCC, (n=131, 34.9%). On the other hand, 22.7% (n=85) indicated that they had no knowledge of CDM, while 26.7% had average knowledge of CDM. These numbers are significant as they depict existing gaps in students' knowledge of climate change, and environmental bodies responsible for addressing issues concerning climate change. A minority (less than 10%) of the respondents indicated that they had excellent knowledge of the environmental bodies. From the statistics displayed below, it is evident that students have limited knowledge about IPCC, REDD+ and CDM.

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Table 6. Knowledge on Environmental Bodies

	None		Little		Average		Good		Excellent		Total	
Body	n	%	n	%	n	%	n	%	n	%	n	%
IPCC	66	17.60	108	28.8	109	29.1	75	20.0	17	4.5	375	100.0
REDD+	63	16.80	102	27.20	123	32.80	74	19.70	13	3.50	375	100.0
Kyoto Protocol	72	19.20	86	22.90	116	30.90	73	19.50	28	7.50	375	100.0
UNFCCC	49	13.10	86	22.90	131	34.90	73	19.50	36	9.60	375	100.0
CDM	85	22.70	93	24.80	100	26.70	68	18.10	29	7.70	375	100.0

3.7 Main source of climate change information among students

A significant number of the respondents across the three schools and the four year levels indicated that the internet (n=186), 49.6% and the television (n=75), 20% are their main source of climate change information. Thus the internet plays a key role in disseminating knowledge about climate as well as creating awareness among students since a significant number of them (49.6%) always have access to it through their personal gadgets or the computer laboratories provided by the institution. These findings corroborate with those of (Hestness*et.al.,* 2019) in which middle school students were discovered to engage with media within and beyond their school –based programs and even prior to the formal instruction on climate change. Thus, media appeared to strongly inform their ideas about climate change (Hestness*et.al.* 2019) Other sources of climate change information were rated as shown in the table below.

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Table 7. Sources of climate change information

Source	n	%
Television	75	20
Radio	12	3.2
Newspaper	11	2.9
Internet	186	49.6
Environmental groups	22	5.9
Friends and family	32	8.5
Books and journals	34	9.1
Other	3	0.8
Total	**375**	**100**

3.8 Popularity of sources of climate change

Various sources of climate change information were ranked as either most popular or least popularOna 5-item Likert scale (1-Most popular and 5- least popular). Media (broadcasting, print and social media) was ranked as the most popular source of climate change information (n=240), 64% while Climate Change Seminars/ Conferences, Lectures and educational programs were ranked as the least popular. Family and friends, as well as books and journals were ranked as average. The outcome is as summarized in the table below.

	1		2		3		4		5		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Lectures/ education programs	27	7.2	60	16.0	58	15.5	102	27.2	128	34.1	375	100
Family, friends & public	53	14.1	92	24.5	125	33.3	62	16.5	43	11.5	375	100
Media (TV,	240	64.0	69	18.4	37	9.9	18	4.8	11	2.9	375	100

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internet)												
CC seminars/ conferences	9	2.4	27	7.2	41	10.9	151	40.3	147	39.2	375	100
Books& Journals	47	12.5	125	33.3	113	30.1	50	13.3	40	10.7	375	100

Table 8. Popularity of sources of climate change information

3.9 Inferential Statistics

The variables of interest in this research were climate change knowledge, awareness, attitude, skills and participation. Since these variables do not have a scale of measure, the Likert scale was used. Likert scale items were constructed for each variable and the respondents indicated their level of agreement with the different items. The collected data was averaged for each variable resulting into new variables that were continuous. The new variables ware then subjected to normality and homoscedasticity test and none was found to be normally distributed or having homogenous variance. Therefore, only non-parametric tests were used to run the required statistical tests.

3.9.1 Climate Change Knowledge by School

Kruskal Wallis one-way ANOVA test was performed to establish if the knowledge and levels of climate change awareness significantly varied. Kruskal Wallis test was used to test for the difference in medians of the three independent groups and their distributions.

Table 9. Climate change knowledge by school

Climate Change Knowledge	School

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	SES	SB	SHSS
Median	4.071	3.683	3.661
Interquartile Range	0.500	0.570	0.570

The median of climate change knowledge level among the students from the School of Agriculture and Environmental Studies is higher (Med = 4.071, IQR = 0.500) compared to that of School of Business (Med = 3.683, IQR = 0.570) and the School of Humanities and Social Sciences (Med = 3.661, IQR = 0.570). This summary gives an indication of a difference being present between the schools in as far as the level of climate change knowledge in concerned. SAES exhibited a higher level of awareness compared to the SHSS and SB. Kruskal Wallis one-way ANOVA was used to establish if there's a significant difference between the knowledge levels of the students from the three schools. The results showed a statistically significant difference in the median climate change knowledge level across the categories of the schools, $\chi^2(2)= 41.138$, $p<0.05$. Additionally, the test results show that there is a significant difference in the distribution of the climate change knowledge level across the three different schools $\chi^2(3)= 17.968$, $p<0.05$. The results were visually displayed in the boxplots output below.

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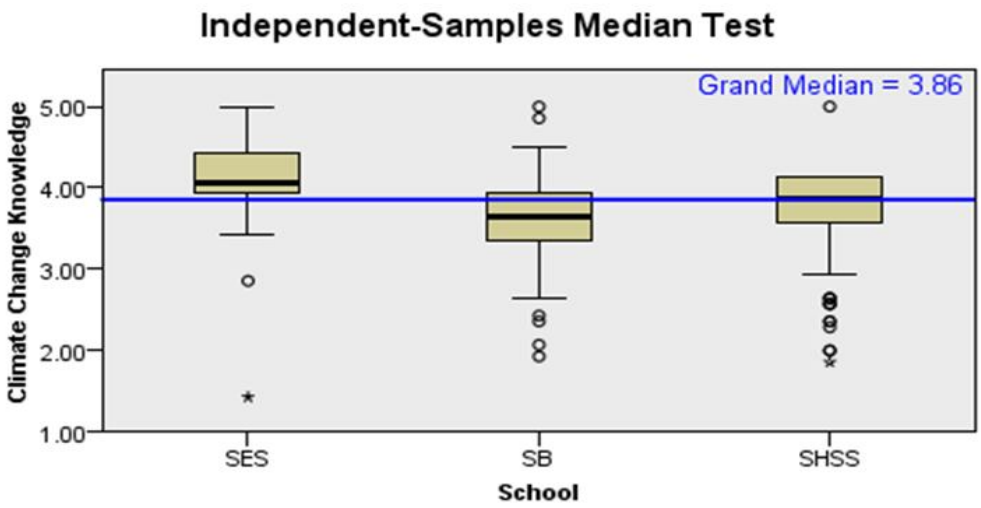

Figure 3. Climate change knowledge by school

The median climate change knowledge level of the School of Agriculture and Environmental Sciences is above the grand median, the School of Humanities and Social Sciences is approximate to the grand median, and that of the School of Business is below the grand median line. This indicates that the School of Agriculture and Environmental Sciences exhibits the highest level of climate change knowledge, while the School of Business has the least. To establish the pair of schools that vary significantly from each other in climate change knowledge and awareness, a pairwise comparison-adjusted using the Bonferroni correction method was performed and the table below was generated.

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Table 10. A pairwise comparison of the schools

Sample1-Sample2	Test Statistic	Sig.	Adj.Sig.
SB-SHSS	15.970	.000	.000
SB-SES	41.149	.000	.000
SHSS-SES	10.551	.001	.003

The pairwise comparison table above shows, all the groups were significantly different from each other. The median climate change knowledge level of the School of Business was significantly different from that of the SHSS and that of the SAES ($p<0.05$). The climate change knowledge level of students from the SAES was significantly higher than that of SHSS and SB

3.9.2 Climate change knowledge by level of study

Students pursuing undergraduate degree courses, are grouped into four levels of study. A summary of descriptive statistics based on the year of study was done and the results were as shown below.

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Table 11. Climate change knowledge by level of study

	Level of Study			
Climate Change Knowledge	1	2	3	4
Median	3.786	3.643	3.786	4.071
Interquartile Range	0.710	0.520	0.430	0.590

Students in their fourth level of study exhibited the highest level of climate change knowledge (Med = 4.071, IQR = 0.590) while students in their first and third levels were found to have the same median knowledge level of 3.786 and interquartile ranges of 0.710 and 0.430 respectively. The students in the second level recorded the least level of climate change knowledge (Med = 3.643, IQR = 0.520). A visual representation of these results is displayed using the boxplots output below.

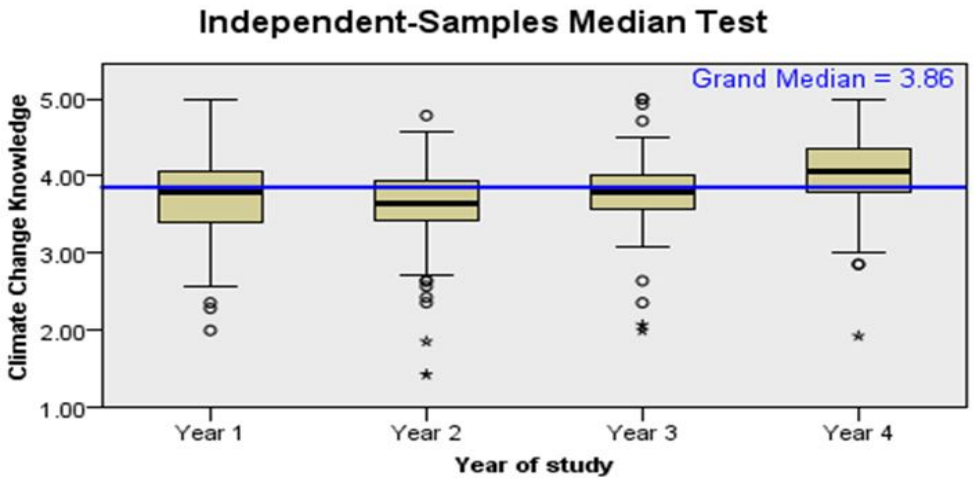

Figure 4. Climate change knowledge by year of study

The median climate change knowledge level of the fourth-year students is the only median above the grand median line. The rest of the years are below the median line,

with the second years' being the lowest. This means that the fourth year students are more informed about climate change compared to other years implying that awareness levels increases with the level of study. To establish if the difference in climate change knowledge level is significant between the students in the different levels of study, a Kruskal Wallis test for similarity of median and distribution was conducted and the results showed that there is a significant difference in the medians of the four groups, $\chi^2(3)= 30.409$, $p<0.05$. Furthermore, the distribution of the four groups was found to significantly vary, $\chi^2(3)= 39.237$, $p<0.05$. To establish the groups that significantly vary from each other, a post hoc comparisons test was conducted and the results were adjusted using the Bonferroni correction.

The findings show that the climate change knowledge level of students in their fourth year of study significantly varies from that of students in their first, second, and the third years of study ($p<0.05$). Likewise, there is no significant difference between the climate change knowledge level for students in their first year and second year, second year and third year, first-year and third year. Based on these findings, the fourth year students are the most knowledgeable on climate change matters. Students in the lower levels of study have a lower level of climate change knowledge and this is statistically similar between the groups.

Similarly, this research found out that knowledge and awareness of climate change varied significantly with age. Thus, respondents who were aged 24 years and above displayed a higher level of understanding of climate change causes and effects compared to those who were 23 years of age and below. Majority of those aged 24

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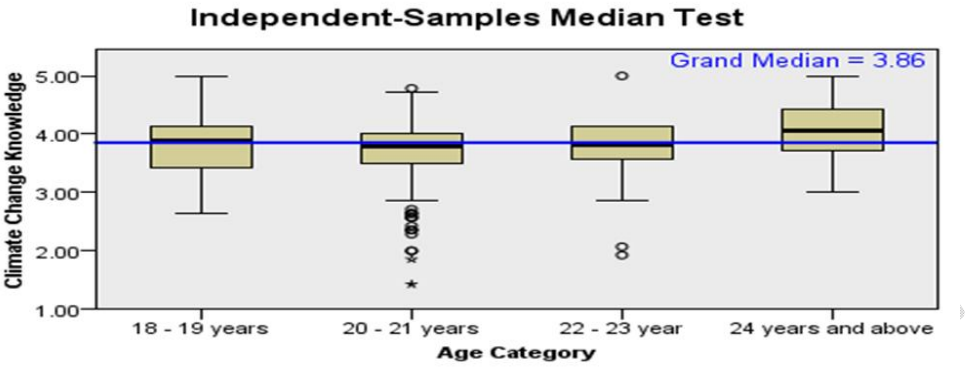
years and above were also in their fourth level of study. A visual representation of climate change knowledge by age is as displayed using box plots output below;



Total N	375
Median	3.857
Test Statistic	11.673
Degrees of Freedom	3
Asymptotic Sig. (2-sided test)	.009

Figure 5. Climate change knowledge and awareness by age

3.9.3 Study Discipline, Awareness and Participation Nexus

The relationship between students' study discipline and participation in mitigation and adaptation was also measured. The following summary table was generated.

Table 12. Climate Change Skills and Participation

Climate Change Skills & Participation	School		
	SAES	SB	SHSS
Median	3.333	2.333	2.667
Interquartile Range	0.670	0.830	1.000

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The table above shows, the median of climate change skills and participation among the students from the School of Agriculture and Environmental Sciences is higher (Med = 3.333, IQR = 0.670) compared to that of School of Business (Med = 2.333, IQR = 0.830) and the School of Humanities and Social Sciences (Med = 2.667, IQR = 1.000). Thus study discipline influences whether students participate in mitigation and adaptation activities or not. A visual representation of these results can be seen better on the boxplots output below

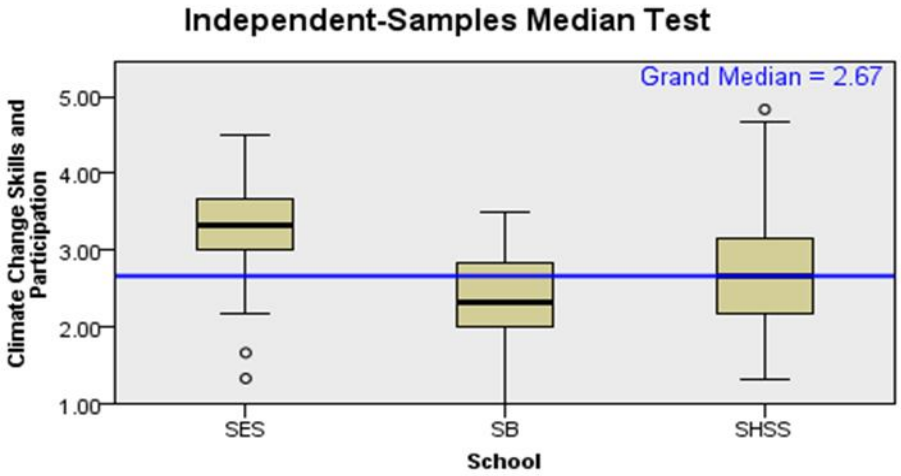

Figure 6. Climate change skills and participation

From the box plots above, it is evident that students in SAES possess more skills in climate change and participates more in mitigation and adaptation measures such as tree planting and garbage collection compared to students in the two other schools. SB however ranks lowest in as far as skills and participation in climate action is concerned This implies that study discipline influences acquisition of skills which intern affects participation in climate change mitigation and adaptation. A Spearman's correlation test was performed to test for the correlation between the four variables under study and the results are as shown below.

Table 13.Spearman's Correlation test of variables

			Climate change awareness	Climate Change Attitude	Climate Change Skills and Participation	Climate Change Knowledge
Spearman's rho	Climate change awareness	Correlation Coefficient	1.000	.408**	0.382**	0.521**
		Sig. (2-tailed)	.	0.000	.000	0.000
	Climate Change Attitude	Correlation Coefficient	.408**	1.000	0.181**	0.336**
		Sig. (2-tailed)	0.000	.	.000	0.000
	Climate Change Skills and Participation	Correlation Coefficient	.382**	.181**	1.000	0.343**
		Sig. (2-tailed)	0.000	0.000	.	0.000
	Climate Change Knowledge	Correlation Coefficient	0.521**	0.336**	0.343**	1.000
		Sig. (2-tailed)	0.000	0.000	0.000	.

All the variables are highly correlated with each other. The strongest correlation exists between climate change knowledge and climate change awareness, while the climate change skills and participation did not exhibit a significantly strong correlation with climate change attitude.

The non-parametric correlation analysis sought to establish if any significant correlation existed between climate change knowledge, awareness, attitude, and skills among the students. The results in the table show that there is a significant positive correlation between the students' climate change knowledge and awareness, $r(375) = 0.521$, $p<0.05$. Climate change awareness among students also has a strong positive correlation with their attitude towards climate change, $r(375) = 0.408$, $p<0.05$. Climate change attitude and climate change knowledge were also found to be significantly correlated among the respondents, $r(375) = 0.336$, $p<0.05$. Thus, when

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students are aware and possess adequate knowledge on climate change, they develop a positive attitude towards the subject and consequently, they respond positively by taking action.

4. CONCLUSION

Awareness levels of climate variability and change among undergraduatestudents of Kenyatta University is significantly low though it varies with age, level of study and study discipline of the student. However, there exists knowledge gaps in terms of causes and impacts of climate change as well as the environmental bodies charged with the mandate of addressing climate change matters.

There are statistically significant differences in knowledge levels of climate change across schools X^2 (2) =41.138), $p<0.05$. Respondents in SAES exhibited a high level of awareness and knowledge of climate change compared to those from SB and SHSS whose knowledge level and awareness was significantly low. The three groups were statistically different from each other. These findings corroborate with those of (Fitzgerald and Roberts, 2015) and (Freije*et.al.*, 2017) in which study discipline and participation in environment activities enhances awareness levels and climate action. Thus, educational background has a significant influence on climate change awareness levels as well as acquisition of skills necessary for climate change mitigation and adaptation.

Student's level of study is also a factor that significantly affects the level of awareness of climate change as there are significant differences in the medians of the four groups representing the four study levels. Climate change knowledge level of the students in fourth level significantly varies from that of students in other three year levels

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implying that fourth year students are more knowledgeable on matters of climate change than First, Second and Third year students. Gender however was not of any significant influence because the level of exposure to climate change information was more or less the same across the two genders.

Study discipline was found to affect the acquisition of climate change skills and participation in mitigation measures such as tree-planting and cleaning exercise Acquisition of climate change skills as well as participation and mitigation and adaptation was higher among students from SES compared to the SB and SHSS respectively indicating that study discipline determines whether students can take action aimed at addressing climate change, because of prior knowledge of climate change and its effects. Thus, study discipline influences acquisition of skills which consequently influences participation in climate action.

The main source of climate change information among the undergraduate students is the internet (n= 186, 49.6%) and television (n= 75, 20%) implying that the internet plays a key role in disseminating knowledge about climate change and creating awareness among the students. Consequently, media is considered the most popular source of climate change information among the undergraduates as it was ranked the most popular source of climate change information while climate change seminars, conferences, lectures and other educational programs were ranked as the least popular sources of climate change information. Thus, students rarely attend climate change seminars and conferences, while lectures do not contain sufficient content on climate change hence ranked as the least popular sources of climate change

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