Survey of Education, Engineering, and Information Technology Students' Knowledge of Green Computing in Nigerian University

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Abstract

The use of computer system is growing rapidly in the world today and there is also growing concern on the environmental hazard associated with its use. This necessitates the need for users' to acquaint with the knowledge of using it in an environmental friendly manner. This study therefore, investigated the knowledge of green computing possessed by university students in Nigeria. To achieve this, survey method was employed to carry out the study. The study involved students from three departments (Computer Science, Engineering, and Education). Purposive sampling method was used to draw three hundred (300) respondents that volunteer to answer the questionnaire administered for gathering the data of the study. Out of the three hundred questionnaires distributed, two hundred and seventy-six (276) were used for data analysis. In all, one hundred and sixty seven (167) respondents were male, while one hundred and nine (109) were female. The instrument used for gathering the data was adapted and modify before it was used. The instrument was subjected to pilot testing to ascertain its validity and internal consistency. The reliability of the instrument showed a .75 Cronbach's alpha level. The three research questions of the study were answer with descriptive statistic (percentage), t-test and Analysis of Variance. The findings showed that the students do not possess adequate knowledge on conscious use of computing system. Also, the study showed that there is no significant difference in the green computing knowledge possesses among male and female as well as among students' from engineering, education and computer science. Based on these findings, the study suggested among other an aggressive campaign on green computing practice among university communities.

Keywords*: Green Computing, Knowledge, Information Technology, Acceptance*

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Introduction

Green computing (GC) is gaining considerable attention all over the world and the need to possess its knowledge has become a topical subject attracting researchers' interest in the recent time. Green computing is defined "as the study and practice of designing, manufacturing, using and disposing of computer devices in a way that reduces their environmental impact (Murugesan, 2007). Bello, Ahmed and Nordin (2013) opined that GC knowledge is a process of understanding the environmental effect of using computing device and how much of energy it consumes through computing process and promotion of computing activities in such a way that computer system that generate less amount of carbon into the atmosphere, consume less amount of electricity and hazard free when disposed are patronized. To Scheid (2011) GC covers using of computing resources in an efficient manner, considering the cost of disposal, recycling and treating of old hardware in an environmentally friendly way.

The essence and objective behind GC therefore is to promote best practice of using technology in order to reduce hazard associated with computing as well as promoting the recycling method and ultimately reduce e-waste. In the world today, information technology device has dominated every aspect of our life, the device is been use to solve human problem. Albeit it is as well been view as a problem to human environment. Murugesan (2010) remarked that the production and use of computer devices consume a lot of energy, not only this, it is reported that the carbon emitted from its use account for 2%in our environment and yet it use will continue to increase leading to more damage to our environment. To this end urgent action is needed to be taken to reduce its negative impact to the barest minimum.

In attempt to go "carbon neutral" many universities are gearing towards green initiative. In United State, over 500 universities have key into the green initiative programme. They pledge to implement plan that lead to waste management, recycling and reduction in energy use. These schools also plan to integrate green computing courses into their curricula in order to make it part of their educational experiences for staff and students (Bello et al. 2013). The question whether it is important for every computer user to have considerable knowledge of green computing is not negotiable considering its impact on our environment (Dookhitraan, Narsoo, Sunhaloo, Sukhoo & Soobron, 2012).

Knowledge is defined as the degree of information an individual possess that enable him/her to assess, interpret react to stimuli around (Blackwell, Miniard, & Engel 2001). A stream of study showed that absent of knowledge to a greater degree can cause a barrier to adoption of green computing practice. For instance, Courtney (2008) reported that lack of knowledge in green computing have greatly influence adoption among IT manager. In a survey study of Nlyte. Software (2010) in United Kingdom showed that 63% of businesses accused their customer of being unaware of carbon footprint associated with internet service.

Lack of knowledge about green computing and the amount of energy it consume explain why some users will leave their system working when not in use (Bello, Ahmad, & Nordin 2013). Explaining the ignorance of computer usage in America, Bello et al. reported the study of Schneider Electric on what an average desktop computer required in terms of energy to stay idle. The study reported that a computer required 85 watts to stay idle and that if the computer is logged off over USD $40 would be saved annually. If we multiply this amount in relation to millions of PC that are left idle everyday all over the world you would wonder how much of money and the energy that would be saved.

The study further reported that a computer left on for 24 hours a day would generate 1,500 pounds of carbon monoxide into the atmosphere and if a tree absorbs 3-5 pounds of carbon monoxide each year, close to 500 trees are required to neutralize the annual emission of one computer left working. Bello et al. (2013) was of opinion that close to billion of trees may be needed to offset the carbon emitted by a computer in all Malaysian universities. By implication if the entire universities in the world left the computer in their laboratory on, either in hibernate or sleep mode, several trillions of trees may be required to neutralize whatever carbon that would be emitted. As terrible as this appears, most users of computer in all nations of the world especially students in developing world are not aware of the consequences of leaving computer on without use.

An attempt to understand the knowledge about GC in Mauritius University by Dookhitram, Narsoo, Sunhaloo, Sukhoo, and Soobron (2013), shows that the students possess moderate knowledge of GC, but their practice of GC in terms of everyday use of computer was not encouraging In a similar study by Ahmad, Nordin and Bello (2013) study on state of GC knowledge among students in a Malaysian public university, the study reported that the student generally lack the knowledge of GC particularly in the area of Energy Star, E-PEAT, Malaysian Green Technology Policy, printer types and energy consumption, energy-efficient practice and hazardous chemical present in computer. Also, the

study of Batlegang (2012) on green computing, students, campus computing and the environment in Bostwana revealed a low level of computing knowledge among the university students in Bostwana.

The study of Wabwobe, Waajembi, Omuterema and Mutua (2013) on pervasiveness of green ICT awareness amongst Keyan ICT personnel shows that awareness of ICT personnel on green ICT is low in Kenya compared to developed nations. The study also show how ICT personnel perceived the importance of GC to their organization. Phunde, Godbole and Sapa (2014) study on students awareness and usage of green computing among male and female students revealed that less than 50% of all the students are not aware of GC, and this is independent of gender.

In a study on the barrier to adoption of GC in higher education institution in Malaysia by Lay, Ahmad and Ming (2014) catalogue the following as the barrier to GC initiative in Malaysia higher institution of learning. The hindrances among other are high adoption cost, lack of environmental knowledge and green awareness, lack of trust, adoption skepticism, institution adoption and switching barrier issues.

The fact remain that ICT use has dominated every aspect of human living. The use of ICT has galvanize the world into the knowledge society in which education industry has been in the forefront of the industry that benefited significantly from its use. At the university level the majority of student constitute the users of ICT, in fact it is part of the required skill for would be student in respective of the discipline of such student. Since this class of ICT user will not only use it when in school but will continue to use it while they were part of technology driven society, therefore they needed to be equipped with the knowledge of using ICT in a responsible manner and eco-friendly way (Ahmad et al. 2014).

As important as the knowledge of green computing is to our immediate environment and the entire world, it is evidence from available literature that there is paucity of study on the knowledge of green computing in the present setting of this study, hence the need to understand how much of knowledge of green computing that the student in Nigerian Universities possess considering the number of this class of user and attendant threat that may arise from misuse of information technology.

Objective of the Study

This study aims at achieving the following objectives:

- To understand the level of knowledge about green computing possess by students in Nigerian university students.
- To examined if there is dissimilarity between the knowledge of green computing possess among male and female student in Nigeria university
- To examined the influenced of field of study on the knowledge of green computing possess among Nigerian university student

Research Questions

- Does Nigerian student possess Knowledge of green computing?
- Is there any significant difference in the conscious use of computer and adoption of green computing practice based on students' gender?
- Is there any significant difference in the knowledge of green computing possess by students based on their field of study?

Methods

The study employed a cross-sectional survey method. The population of this study comprised students of Federal University of Technology Minna. Nigeria. Students from School of ICT, Education, and Engineering constitute the sample use. The sample was selected through purposive sampling technique. Out of three hundred questionnaire administered, two hundred and seventy-six (70%) was found usable for this study. The instrument of the study was adapted from Ahmed et al. (2013) study on knowledge of green computing. The validity and reliability of the instrument was ascertained through pilot testing, the reliability index of 0.80 Cronbach-alpha was obtained.

The profile of the participants in (figure 1) shows that out of two hundred and seventy-six students' sample, one hundred and sixty-seven representing (66.5%) were male, while one hundred and nine representing (33.5%) were female. Participants from school of ICT were 89 (32.2%), schools of science and technology education were 76(27.5%) and School of engineering were 111 (40.3%).

The instrument of the study contained three sections, the first section request for respondents' profile. The second section comprises of seventeen items on student knowledge of green computing.

The respondent were asked to tick an option that range from "TRUE", "FALSE", and "I DON'T KNOW" to these items.

The third section of the instrument contained items on environmentally conscious use of computer, and student intention to use green computing practice. The instrument was adapted from Ahmad et al. (2014), the scale provided as option to be chosen ranges from "STRONGLY AGREE", "AGREE", "NEUTRAL", "DISAGREE" and "STRONGLY DISAGREE". To answer the research questions of this study, the following statistical analysis were computed. The first research question was computed with descriptive statistic using frequency count and percentage, the second and third questions was analyze with inferential statistic using t-test and analysis of variance (ANOVAs).
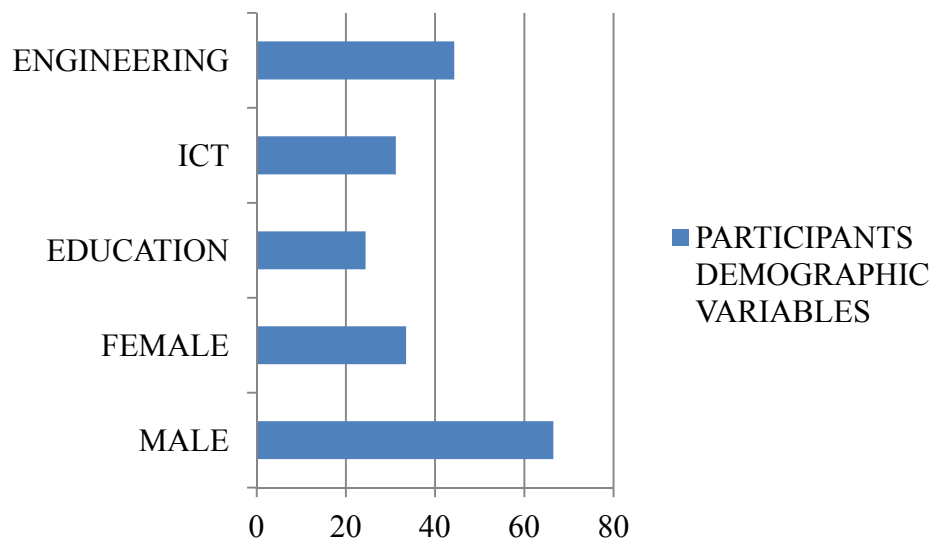

Figure 1. Profile of the respondents

Data Analysis
Result
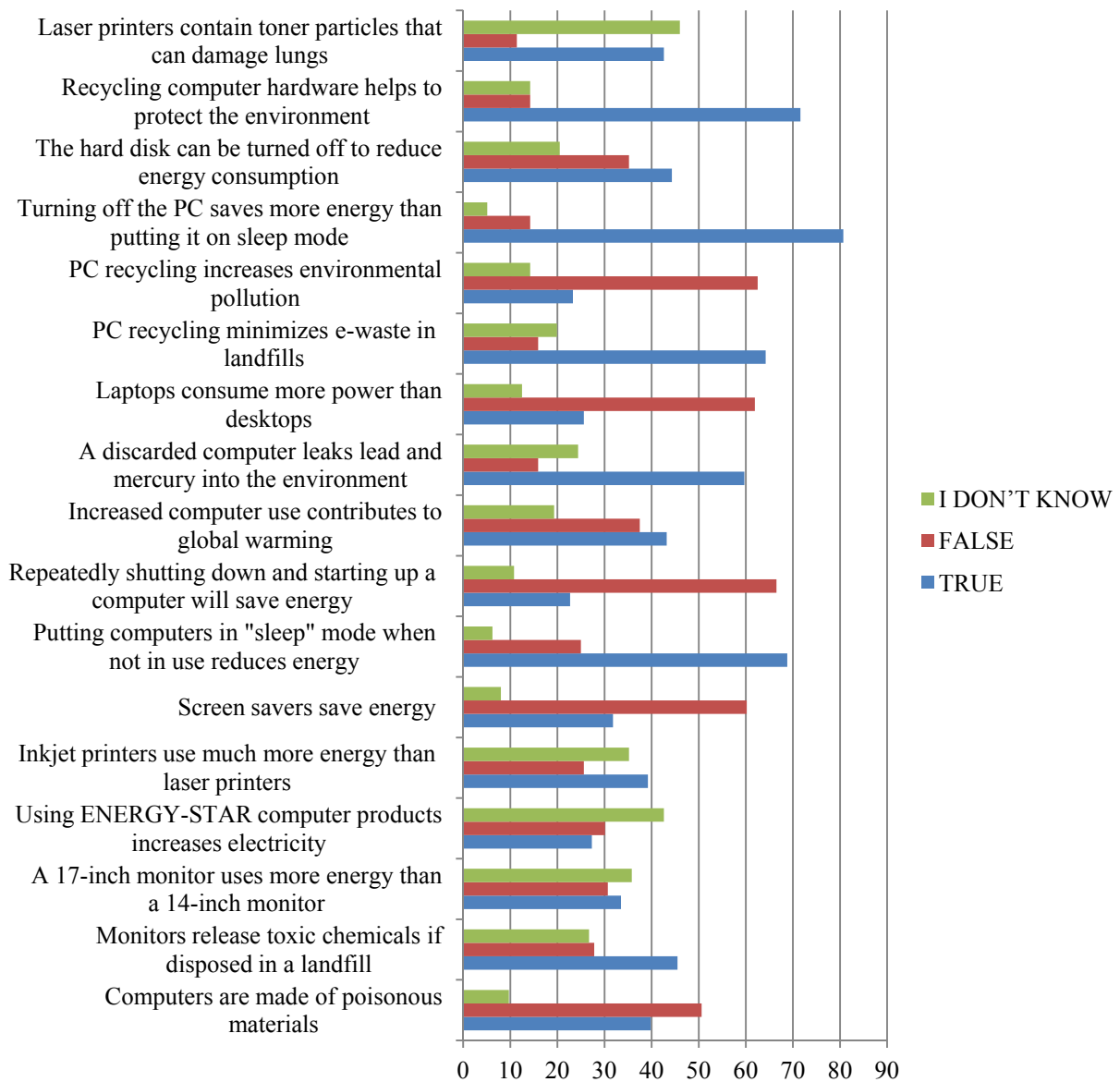Q1: Does Nigerian student possess Knowledge of green computing?

Figure 2. Frequency of students' knowledge about Green Computing (N=276)

The student knowledge on green computing was gauge to ascertain their level of understanding on what constitute green computer practice, the finding in (fig 2) showed that the students response on *"laser printer contain toner particle that can damage the lung"* revealed that majority of the students 46% indicated not to know the answer, while 42.6% choose true option and 11.4% choose false option. The item on *"recycling computer hardware helps to protect the environment"* showed that 71.6% of the students choose true option, while 14.2% choose false option and the remaining 14.2% choose not to know the answer. On the item *"the hard disk can be turned off to reduce energy consumption"* showed that majority of the student 44.3% choose true option, while 35.2% choose false option and the remaining 20.5% choose they do not know the answer. The item on *"turning off the PC saves more energy than putting it on sleep mode"* showed that 80.7% of the students choose true option, while 14.2% choose false and 5.1% choose I don't know option. The item on *"PC recycling increases environmental pollution"* showed that majority of the students 62.5% choose false option, while 23.3% choose true option and 14.2% choose I don't know option. The item on *"PC recycling minimizes e-waste in landfill"* showed that majority of the students 64.2% choose true option, while 15.9% choose false option and the remaining 19.9% choose not to know the answer. The item on *"laptops consume more power than desktop"* showed that 25.6% of the students choose true option, while majority of them choose61.9% choose false option and 12.5% choose not to know the answer. The item on

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"discarded computer leaks lead and mercury into the environment" showed that 59.7% of the students choose true option, while 15.9% choose false option and 24.4% choose I don't know for an answer.

The response of the students to "increase computer use contributes to global warming" showed that 43.2% of the students choose true option, while 37.5% choose false option and 19.3% choose I do not know option. The response of students to "repeatedly shutting down and starting-up a computer will save energy" showed that 22.7% of the students choose true option, while 66.5% choose false option and 10.8% choose I do not know option. The response of students to item *"putting computer on sleep mode when not in use reduce energy"* showed that 68,8% of the students choose true option, while 25.9% choose false option and 6.2% of them choose I do not know option.

Students response to item on *"screen saver save energy"* revealed that 31.8% of the students choose true option, while 60.8% choose false option and 8.0% choose I don't know option. On the item *"inkjet printer use much more energy than the laser printer"* the response of the students showed 34.2% of the students choose true option, while 26.5% choose false option and 35.2% choose I don't know option. The student response to the item *"using ENERGY-STAR computing increases electricity"* revealed that 27.3% of the students choose true option, while 30.1% choose false option and 42.6% choose I don't know option. The response of the students to the item *"a 17-inch monitor uses more energy than a 14-inch monitor"* showed that 33.5% of the students choose true option, while 30.7% choose false and the remaining 35.8% choose I don't know option. The students' response to *"monitor release toxic chemical if disposed in landfill"* showed that 45.5% of the students choose true option, 27.8% choose false and 26.7% choose I don't know option. On the response to *"computers are made of poisonous material"* revealed that the students 39.8% choose true option, 50.6% choose false option and 9.7% choose I do not know option.

Research Question 2: Is there any significant difference in the use and intention to adopt green computing based on students gender?

Table 1. Descriptive analysis of male and female student knowledge on green computing

	GENDER	N	Mean	Std. Deviation	Std. Error Mean
MALE	167	21.1966	4.39482	.40630	
FEMALE	109	21.4746	3.83880	.49977	

Table 2. t-test analysis of difference between male and female students knowledge on green Computing

	F	Sig	t	df	Sig (2tail)	Mean diff	Std error diff	95% Conf, interval Lower	upper
Equal Variance assumed	.283	.595	-.413	274	.680	-.278	.673	-1.607	1.051
Equal Variance not assumed					.667	-.278	.644	-1.552	.996

P= < 0.05

An independent sample t-test was conducted to compare male and female students' conscious use of computer and their intention to adopt green computing practice. The result in (table 1&2) above showed there is no significant difference between male students (M= 21.20, SD =4.39) and female students (M=21.47, SD=3.84); t (274)= 0.41, P=.68 (two tailed). The magnitude of the difference in the means (Mean difference = -28, 95% confidence interval is practically not important. This revealed that both male and female have equal knowledge and the same in terms of conscious use of computer.

Research Question 3: Is there any significant difference in the knowledge of green computing possess by students based on their field of study?

Table 3. Descriptives table of mean and standard deviaton of knowledge of green computing base on student field

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
EDU	43	21.51	4.78	.73012	20.0382	22.9851	11.00	30.00
ICT	55	20.76	4.05	.54678	19.6674	21.8599	12.00	32.00
ENGR	78	21.53	3.98	.45169	20.6390	22.4379	13.00	34.00
Total	176	21.28	4.20	.31716	20.6638	21.9157	11.00	34.00

Table 4. ANOVA table of students knowledge of green computing based on their field of studies

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	22.166	2	11.083	.623	.537
Within Groups	3076.056	273	17.781		
Total	3098.222	275			

P=< .05

A one-way between groups analysis of variance (ANOVA) was computed to explore if there is any significant different in the students' knowledge of green computing based on their field of study. The finding in table 3 & 4 showed that there is no statistical difference in student knowledge about green computing, as reflected in the mean and standard deviation of the three groups (EDU, ICT, & ENGR) as shown in (table 3) EDU (M=21.51, SD=4.78); ICT(M=20.76, SD=4.05); ENGR (M=21.53, SD=3.98). There is no significance difference at $p < .05$ level for the three groups $F (2,173) = 0.62$, p= 0.5. Practically the mean difference in between the groups is quite small hence; there is no need to calculate the effect size or look into post-hoc comparison. This finding suggests that students from the three groups (Education, ICT and Engineering) were the same in terms of their green computing knowledge.

Discussion

The findings from this study show that the respondents have little knowledge of green computing which invariably hinder their conscious use of computing devices. For instance greater percentage of the student chooses I don't know to some questions (e.g question 1, 14, & 15), while majority of the student fail to provide correct answer to some questions (5, 7, 10, 12, & 17). Some of these questions are "laser printer contain toner particles that can damage the lung", "using ENERGY-STAR computer products increases electricity", "a 17 inch monitor uses more energy than a 14 inch monitor".

Among the items which majority of respondents could not answer correctly are "PC recycling increases environmental pollution", "Laptop consume more power than desktops", "Repeatedly shutting down and starting up a computer will save-energy", "Screen saver save energy", and "Computer are made of poisonous materials". Some of the respondents that were able to answer some of the questions, by ticking the right answer does so through a quest work. This finding supported Dookhitram et al. (2012), Batlegang (2012) and Phunde, Godbole, and Sapa (2014) study that reported that university student failed to show understanding of some basic things about computer, like practice of screen savers, putting system in a sleep mode and switching off the system when not in use. The finding show that the students do not know that the system still consume the same amount of energy be it in sleep-mode or not.

For instance, some of the questions which was incorrectly answer are questions which is presume to be known by the students, though ICT students demonstrated to answer some of these questions correctly. This is not to conclude that they are more conscious of green computing despite the evidenced that they are more literate as reflected in their response, but surprisingly, the analysis on student field of study revealed that there is no significant different in the conscious use of computer among all the respondents of the study, this finding was in disagreement with Bello et al, (2013) finding that reported that student in ICT are conscious of green computing than non-ICT student. Finding on whether there would be significant difference in students knowledge about green computing among male and female students revealed that there is no significant different between male and female students knowledge about green computing in the setting of this study. The finding supported Phunde, Godbole, and Sapa (2014) that revealed that male and female are not differed in term of green computing knowledge, the finding however, was not in congruent with Ahmad (2013) finding that reported higher level of knowledge of green computing demonstrated by female as against their male counterpart in a Malaysian University. Though, in practical term the effect of the difference was reported to be small.

Conclusion and Recommendation

The findings of this study have revealed that greater percentage of the students in the setting of the study possess low knowledge of green computing. Generally, they are not conscious user of computer and its accessories. The finding has unveiled and shed light to the state of knowledge of green computing among the students in the sample of the study. Therefore, the study has contributed to

literature on the phenomenon and suggests a further study on the awareness and acceptance of green computing among academic staff in Nigerian University, since they constitute a huge segment of ICT users. Base on this findings the following suggestions are made:

- An urgent attention is required by way of creating awareness on safe use and acceptance of environmentally friendly computing practice among the students.
- The university should as a matter of urgency organize workshop and seminal to educate staff and students on what green computing is all about
- Set-up committee to promote acquisition of eco-friendly computer in the university and encourage behavioural change in the usage pattern to reduce the carbon foot-print of computer user in our University.

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