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GREEN COMPUTING KNOWLEDGE AND PRACTICES OF UNDERGRADUATE STUDENTS

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ABSTRACT

The term "green computing" has become widely popular and many computer users are taking an environmentally friendly action that maximizes the usefulness of computing resources while minimizing the negative impact to the environment during their operational use. This observation directed the researcher to conduct a study on green computing. This study attempted to determine the level of green computing knowledge and practices of students. The respondents of the study were undergraduate students of Pangasinan State University – Bayambang Campus. The study used the descriptive-survey method of research to analyze, interpret and report the present status on the level of green computing knowledge and practices of students. Research data were collected using the researcher-made questionnaire. Percentages, mean, and weighted mean were employed to analyze the research data. The study found out that undergraduate students have a moderate level of knowledge on green computing and moderately practiced green computing practices that are friendly to the environment.

Keywords : green computing, computing knowledge, computing practice, energy consumption, eco-friendly, computing resources

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INTRODUCTION

Green computing refers to the "eco-friendly and environmentally responsible use of computers and their resources". In broader terms, Murugesan [1] defined green computing as the study and practice of designing, manufacturing, using and disposing of computer hardware, servers, and associated peripherals such as printers, monitors, storage, networking devices and communication devices effectively and efficiently with minimal impact in the environment. Green computing covers the broad scope of energy efficient computing practice; in that it promotes computing activities and use of computing resources that consume only the necessary amount of energy and produces the least amount of emissions into the atmosphere. Green computing also covers hazard-free computing because it supports the utilization and disposal of computers and their resources in responsible and non-harmful ways to the user and environment.

Green computing started as early as 1992 when Energy Star program was created by the

Environmental Protection Agency (EPA) which is a voluntary labeling program that encourages energy-efficient computing technologies. Because of this program, many IT manufacturers are continuously investing in designing energy-efficient computing equipment, minimizing the use of hazardous materials, and encouraging recyclability of paper and digital devices.

Nowadays, many organizations and computer users began to adopt green computing and are taking environmentally responsive activities, such as duplex printing and printing only when necessary, switching off equipment when not in use, shifting personal computers from desktop to laptop, using cloud computing, and virtualization software [2]. However, since most businesses rely on information technologies by using computing resources to perform numerous tasks, the production, use, and disposal of wastes of computing equipment would eventually damage the environment. Servaes [3] stated that the production and use of computer resources are energy consumptive since they account for 2% of the total carbon emissions. In today's global economy, the use of computing devices will continue to rise, leading to more damages if not appropriate actions are taken to lessen or eliminate the corresponding environmental risks.

Green computing is becoming one of the most trends in many areas all over the world. Yet many IT users, especially students are not sure what it means. Therefore, the adoption and implementation of green computing require that ICT users be educated about what constitutes sustainable green computing, what characteristics and features make a computer a green PC, and what computing practices are compliant to a green environment. As stated by Rogers [4], knowledge is the first step in the adoption of any process. Lack of knowledge in energy-efficient computing has in fact already led to much financial loss and energy wastage. According to Jenkin [5], almost half of the world's energy wastage is attributed to uninformed behaviors of users and consumers. Furthermore, Courtney [6] asserted that lack of knowledge in energy-efficient computing is a barrier to the implementation of green computing practices.

This study aimed to determine the level of green computing knowledge and practices of students. Students around the world contribute a massive part of IT users and are accountable for the global carbon emissions attributed to green computing activities [7]. In today's education setting, almost every aspect of learning is influenced by ICT, and students will spend most of their lives in a technology-driven world. As such, they must be equipped with knowledge to use ICT wisely as well as the use in responsible and eco-friendly ways.

MATERIALS AND METHOD

Research Design

This study used the descriptive-survey method of research. According to Calmorin [8], descriptive research is designed for the researchers to analyze, interpret and report the present status of the study, matter, or problem, or the cross-section of the present times. These characteristics allow the researcher to employ the research in an objective and statistically valid way. The objective of the study is to determine the level of awareness of green computing among students, particularly their green computing knowledge and practices.

Subjects of the Study

A total of 100 students randomly selected from different departments of Pangasinan State University – Bayambang Campus during the second semester of the school year 2016-2017 served as respondents of the study.

Data Gathering Instrument

The primary data gathering instrument that was used in the study was the researcher-made questionnaire. The questionnaire was composed of two parts. The first part (Part I) of the questionnaire measured the students' knowledge of green computing. The green computing knowledge of the students was assessed through fifteen (15) True-False items on various aspects of environmentally sustainable computing. The second part (Part II) was the three-point likert type questionnaire used to assess the students' practices of green computing.

Statistical Treatment of Data

The following statistical tools were used in the study.

Percentages and mean were used to determine the student's knowledge on green computing while weighted mean was used to determine the green computing practices of the students.

The following scale was used to describe the level of students' knowledge of green computing.

Scale value	Description
10.51 – 15.00	High knowledge
5.51 – 10.50	Moderate knowledge
0.00 – 5.50	Low knowledge

Likewise, the following scale was used to describe the level of students' practice of green computing. For negative statements the reverse of assigning values was made.

Scale value	Description		Interpretation
	Positive Statement	Negative Statement	
2.51-3.00	Always	Never	Highly practiced
1.51-2.50	Sometimes	Sometimes	Moderately practiced
1.00-1.50	Never	Always	Never practiced

RESULTS AND DISCUSSIONS

Green Computing Knowledge of Students

Table 1 shows the students' performance on their knowledge of green computing.

Table 1. Green Computing Knowledge of the Students

Items	Correct Answer	Wrong Answer
1. Computers are made of hazardous materials.	27%	**73%**
2. Computers leak lead and mercury into the environment if discarded.	48%	**52%**
3. Monitors release toxic chemicals if disposed in a landfill.	42%	**58%**
4. Laser printer contains toner particles that can damage lungs.	38%	**62%**
5. Computer use contributes global warming.	**60%**	40%

6. Laptops consume more power than desktop.	41%	**59%**
7. Screen savers save energy.	27%	**81%**
8. Ink jets use more energy than laser jets.	23%	**77%**
9. A 17-inch monitor uses more energy than 14-inch monitor.	**53%**	47%
10. The hard disk can be turned off to reduce energy.	40%	**60%**
11. The sleep mode reduces energy.	**74%**	26%
12. Shutting down saves more energy than using sleep mode.	40%	**60%**
13. PC recycling increases environmental pollution.	37%	**63%**
14. PC recycling minimizes e-waste in landfills.	48%	**52%**
15. PC recycling protects the environment.	**74%**	26%
	Mean = 6.72	

Table 1 revealed that majority of the students got incorrect answers in the eleven items out of fifteen. It ranged from 52 percent to 81 percent on items such as "Computers leak lead and mercury into the environment if discarded ", "PC recycling minimizes e- waste in landfills and on the item "Screen savers save energy". The five items revealed that students were ignorant about these issues because few students provided the right answers. These five items had more than 60% of the total incorrect answers and these were "Screen saver saves energy" (81% incorrect answers), "Inkjet use more energy than laser printers (77% incorrect answers), "Computers are made of hazardous materials" (73% incorrect answers), "PC recycling increases pollution" (63% incorrect answers) and "Laser printers contain particles that can damage lungs " (62% incorrect answers). These results suggest that students have misperception that screen savers save energy and lack of knowledge of materials used to manufacture computers, energy consumption between inkjet and laser jet printers, PC recycling benefits and the actual nature of screen savers.

In addition more than half of the students were not aware that computers leak harmful chemicals into the environment if inappropriately disposed (52% incorrect responses), PC recycling minimizes e-waste in landfill (52% incorrect answers), monitors releasing toxic chemicals if disposed in a landfill (58% incorrect answers), shutting down saves more energy than using sleep mode (60% incorrect answers) and hard disk can be turned off to reduce energy (60% incorrect answers).

On the other hand, only a few aspects showed a majority of students having knowledge on green computing. These aspects were the function of sleep mode in reducing energy consumption by computers (74% correct answers), the role of PC recycling in protecting the environment (74% correct answers), the fact that using computers contributes to global warming (60% correct answers) and the fact that larger-sized monitors consume more electricity than smaller-sized monitors (53% correct answers).

Table 1 further show that the overall mean of the students is 6.72. This implies that students have moderate knowledge about green computing. They do not know much what green computing is and what computer power management capabilities and energy-saving techniques that can be used to have a green PC. This finding is supported with the study of Dookhitram [9] which reported that Mauritius students pursuing ICT-related degree programs have moderate level of green computing knowledge. As observed also by Batlegang [10], college students are generally oblivious to the negative impact of computers and have limited knowledge on issues of green computing such as energy-saving techniques of using computer resources.

Green Computing Practices of the Students

Table 2 shows the distribution of students in terms of their level of agreement regarding their green computing practices.

Table 2. Green Computing Practices of the Students

Items	Never	Sometimes	Always
1. Use the screen saver function.	5%	38%	**57%**
2. Use the monitor sleep function.	29%	**39%**	32%
3. Use the system sleep function.	25%	**46%**	39%
4. Turn on computer only when the need arise.	28%	**45%**	27%
5. Keep the computer turned on even when away.	19%	**65%**	16%
6. Try to reduce the amount of time spent using computers.	22%	**41%**	37%
7. Turn on all peripherals every time the computer is turned on.	18%	**61%**	21%
8. Turn on peripherals only when I need to use it.	21%	**46%**	30%
9. Turn off entire computer system when out of a long break.	8%	32%	**60%**
10. Printing on paper only when necessary.	11%	**62%**	27%
11. Printing on both sides of the paper if possible.	**61%**	30%	9%
12. Save documents on disk rather than printing on paper.	24%	**43%**	33%
13. Send documents via email rather than by hardcopy.	27%	**54%**	19%
14. Try to reduce the number of pages when creating document.	36%	**51%**	13%
15. Use multipage printing.	**66%**	22%	12%
AWM = 1.94			

Table 2 reveals that two out of fifteen green computing activities were always practiced by the students. It was observed that more than half of the students (57%) always practiced the use of screen savers. Only 5% of the students never practiced this activity, while 38% responded sometimes. It appears that students are unaware of the fact that screen saver consume the same amount of energy as any running application. It was also observed that "Turning off computer system when out of a long break" (60%) was always practiced by students. This indicates that students were not ignorant of the implications of their energy waste and aware that powering down computer system is an effective way to reduce computing power consumption. Likewise, the use of monitor sleep function (39%), system sleep function (46%), turning on computer only when the need arise (45%), reducing the amount of time spent using computers (41%) and turning on peripherals only when needed (46%) were sometimes practiced by the students. However, 65% of the students sometimes keep the computer turned on even when away. This result was supported by Pearce [11] which reported that majority of students never shutdown their computers while Creighton [12] discovered a shocking 80% to be engaged in this habit of leaving their computers on all the time and Dookhitram [9] found that 82% of students were not conscious of wastage and do turned off their computers when not in use.

It was also observed in Table 2 that about two-thirds of the students never practiced "multi-page printing"(66%) and "Printing on both sides of paper" (61%). This might be because double–sided and multipage printing is not applicable to the printing layout or format to the students, especially for their projects. Students do not realize that multi-page and double-sided printing lessens consumption of paper and save energy used to make new paper. Reducing paper consumption causes less trees to be cut down which is good to the environment and good for human race since the more trees means the more also the oxygen to breathe. On the other hand, "Printing only when necessary" (62%) and reducing the number of pages when creating documents (51%) was sometimes practiced by them. The remaining computing practices were also sometimes practiced by the students and these were "sending documents via email rather than hardcopy" (54%) and "saving documents on disk rather than printing on paper" (43%)**.**

The average weighted mean (1.94) suggest that the green computing practices that are friendly to the environment are moderately practiced by the students. This implies that undergraduate students

were not fully aware of what constitutes sustainable computing and what computing practices are compliant to the environment. This finding is supported by with the study of Dookhitram [9] that the everyday green computing practices of students were not satisfactory.

CONCLUSION

Conclusions

Based from the significant findings of the study, the following conclusions were generated. Students have moderate knowledge of green computing. The green computing practices were moderately practiced by the students.

Recommendations

In order to equip students with knowledge to use information technologies effectively as well as the use in responsible and eco-friendly ways, the following recommendations were suggested. Teachers should promote awareness on green computing so that students will have knowledge on best practices that are compliant to the environment. Teacher may also organize seminars geared toward green computing which may lead to behavioral changes of the students such as pc recycling and proper disposal, reducing waste and energy consumption. Teachers and administrators should include green computing policies in all subjects curriculum.

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