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A SUGGESTIVE MODEL TO ADOPT GREEN COMPUTING AT ACADEMIC LEVEL

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***Abstract*—** In current scenario, the increasing upsurge in using digital equipment and electronic gadgets has led to upsurge in carbon emission, climate change, global warming, most importantly energy consumption. Due to these rising environmental issues, green computing is gaining more attention among people. A worldwide level many universities and organization have adopted or trying to be more adoptive and aware in the context of green computing. In some state, literacy ratio of people towards these environmental issues is not as much as good. This Study presented a suggestive model that may be useful for students to understand the green computing and may assist the practitioners to bring environment healthy green practices in their regular life. In this paper, we presented several actions that should be taken while using computer and other peripheral devices. The present model presented the difficult initiative that needs to be taken at education level in order to aware students about raising environmental issues. This model can be helpful for further study at broader scope in term of green computing.

Keywords— Green computing, Environmental issues, Campaign, Carbon emission, energy saving practices.

I. INTRODUCTION

As Per recent upsurge in environmental related issues such as global warming, climate change, high emission of hazardous gases, depletion of natural resources and most importantly huge amount of loss in overall world's energy level. Software and manufacturing of digital equipment may lead to high energy cost. So as per requirements to solve such kind of issues green computing is becoming an essential task of IT- users. Now a day, Energy consumption has been considered as a major challenge for computer users so it is necessary to make aware students and bring green computing in their practices. Africa and Nigeria has great potential for promoting green computing because of higher daily solar radiation of up to 220 W/m2 [Nwankwo, W., Olayinka, A.S., and Ukhurebor, K.E.,2020]. The fact is that implementation of green computing in daily routine is not possible to bring in practices in few days; it will take some time because every kind of changes required small efforts taken by us in routine life. In few past decades user are becoming familiar with term greening in activities done by them. But IT department is responsible for large amount of CO_2 emission so it is necessary for every computer user who must be aware about raised environmental issues caused by computing devices and its associative devices as well as required cooling devices. About 70-80% of energy emission is due to manufacturing of computer devices and most of hazardous gases released from scrap and e-waste import and export for trade purpose [S. Taruna, 2014].

A term green computing is proving itself very helpful in order to reduce carbon footprint and environmental impact. Green computing is just a practice of designing, implementing, deploying, manufacturing and disposing computing devices such as servers and its associated sub component or peripheral in such a way that they do not put their negative impact on environment in parallel of making system effective and efficient. To adopt green IT strategies should not only improve environmental impact, but also increase economic growth of country [Waheed and Seddon,

2011]. In this presented paper, we have tried to present a model that can be helpful for computer user in order to increasing their knowledge, awareness as well as practices in green computing fields. Here we describes about how can we make aware a students about adoption of green computing practices in their routine at education level. Some of basic practices such as turn off ideal electronic devices, put PC on sleep mode can be adopted in routine life. But still there are some lack of awareness and knowledge among students so here we presented some ways that may be effective in educational life and that may help to students to getting more aware and able them to gain much knowledge about such an environmental concerns and amount of CO2 emission in environment.

If students will be aware about such issues related to environment, if they have enough knowledge about these all activities; it may be helpful for them to adopt green practice in their every activity done with digital or computing equipment's.

II. BACKGROUND OF THEORY

The paper presenting suggestive model of green computing adoption at academic level, here we have presented some literature on related study that are based on different aspects of green computing awareness and adoption. Almayelu Molla (2008) presented a model with business perspective that helps to define green IT with different aspect that interrelated which consist the technological, organizational, environmental variables. Tunku (2013) explored a study by indicating the importance of green computing education into higher studies with covering economic and environmental aspect. A life cycle of green IT proposed by prof. Riyaz A. Sheikh (2010) from business and environmental perspective by providing responsibility and useful guidelines in order to maximize the usefulness of electronic devices. Emmanual freeman (2016) proposed an adoption model under the external and internal organization influence and behavioural adoption of green computing. Individual's attitude and behaviour affects positively or negative on green practices. Implementation of Green IT strategies leads to reduce cost and other financial benefits in parallel of cut of the energy cost[Waheed Ibrahim, Seddon, 2011]. To implement go green project, students should be provided a virtual world where they can feel and experience the requirement of Green IT [Henk plessius, 2013].

III. RESEARCH GAP

By analysing different studies on related topic it is found that awareness and knowledge about green computing among students are not provided as required as it is at academic level. Many authors presented related study but it is not spread over at education level, if it is then students are not habitual to adopt green practices in daily routine and while working with computer. So by proposing this suggestive model, we want to throw a light on the actual differences between students' awareness and practices towards green computing. This study offers a room for diverse their mental intention into their actual activity that will be intended to save environment and future.

IV. OBJECTIVES

1. To encourage students to adopt green in routine.
2. To propose a suggestive model to increase level of awareness among students.
3. To increase the level of knowledge about green computing among students.

V. A SUGGESTIVE MODEL

As per growing requirement of digitalization in every field and activity done by human being that causes lot of carbon di oxide and consume energy also that need to control in order to ensure the environment protection as well as provide a healthy environment to students. In order to fulfil our goals here a suggestive model is presented. The Model demonstrates the actual impact of green computing on students. Aim of the study and presented model to bring green computing in practices among all students at academic level. The model may help to encourage students and

other people to adopt green computing while working with digital equipment. Model is also helpful to describe the environmental concern and provide a guidance to calculate the carbon footprint emitted by their activity. So they can motivate and can be able to control overall amount of carbon emission generated by activities and equipment used by them. The proposed model has three basic key challenges that may helpful to reduce the negative impact on environment as well as increase the awareness and knowledge among people. Green computing awareness, knowledge and practice are the main key factors of this model.

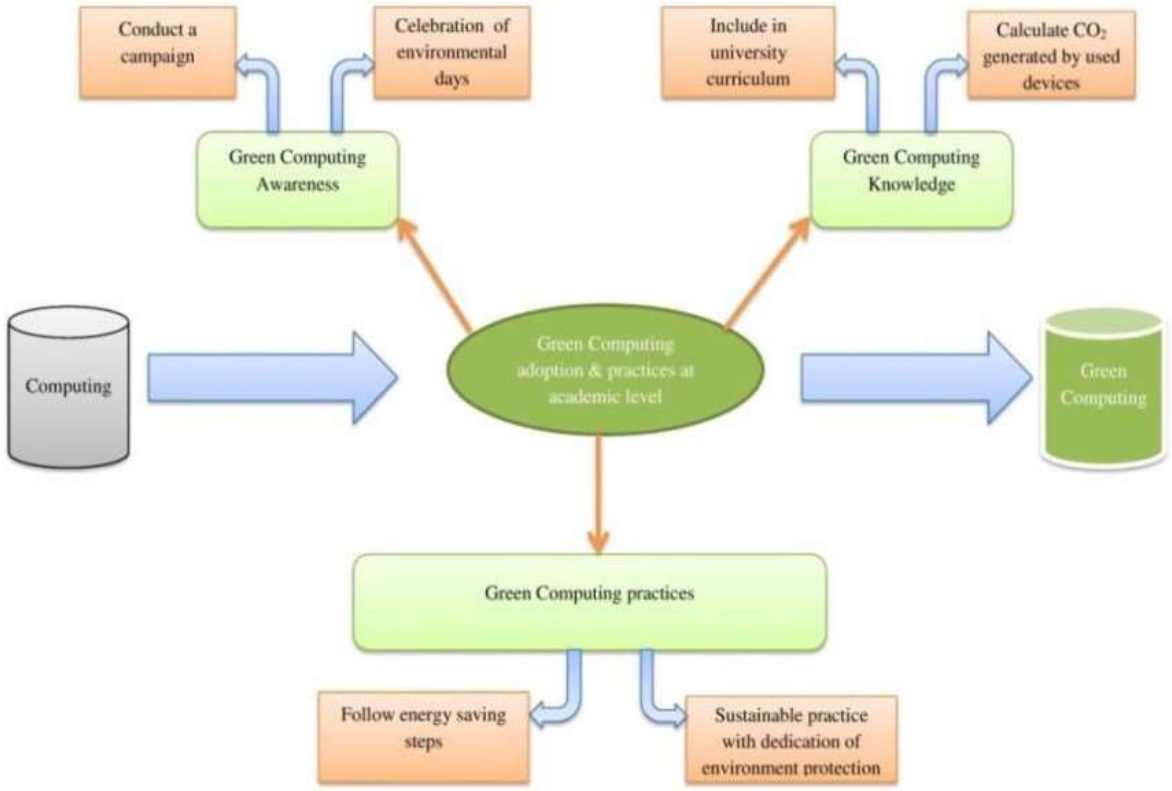

FIGURE 1: A SUGGESTIVE MODEL: GREEN COMPUTING PRACTICES AND ADOPTION AT ACADEMIC LEVEL

A. Green Computing Awareness:

To promote awareness of green computing among people we have to emphasize on the importance of green computing. Some people are yet not known to green computing term; if they are, then they do not much aware towards this direction so here we can put some efforts that might be helpful initiative in order to spread awareness among students as well as common citizens.

a. By conducting campaign:

Literature of green computing is complete with much of awareness spreading among computer users. But it extremely limited in some areas. If we go with the good strategies of campaign, that makes our efforts more effective. Strategy applied with campaign is an art that helps to achieve campaign's objective and bring it into practices.

The campaign strategies main element include focus, goal, vision, critical path analysis, organizational consideration, targets, objectives, evaluation and success indicators.[ref. common library]. In order to open up awareness among students and attract them with some inspiring concept, the paper presented some implementable ideas that can help to achieve objectives. Those are follows:

- By arranging a seminar for students.
- By playing games related to it.
- By playing 3D videos
- By designing learning model.
- By presenting a student as motivator.
- By demonstrating our goal on the basis of interest of students.
- By conducting energy star campaign.

University can initiate simple yet effective awareness campaign by putting up poster around

campus, posting message in classrooms, lecture hall and laboratories, having a green ICT one stop centre for question, queries and e-waste collection services and organizational informal talks [Tunku Badariah, Ahmad, Bello and Nordin, 2013].

b. By Celebrating environmental days:

In order to spread awareness among students some steps must be taken in which some of the days that are relates to environment, nature, earth, green ICT and natural sources can be celebrated with students so they can feel their surroundings nature and environment. Some of the following list of environmental days that are celebrated in order to spread awareness about environmental concerns. Such as world environment day (5 June), earth day (22 April), world biodiversity day (22 May), world forestry day (31 March), International mountain day(11 Dec), Zero emission day (21 September), Ozone Day (16 Sept), International climate change day (21 June), World nature conservation day (28 July), International day of climate action (24 October) , Global recycle day (18 March) etc. are such days that aims to encourage the awareness about environment.

B. Green Computing Knowledge:

According to study and analysis previous study many of the students do not have much knowledge about environment related issues, negative impact of their activity on environment, impact of global warming on earth and health, carbon emission by hardware and software, power consumption problem, energy cost etc. so it is necessary to provide proper knowledge about all above issues to students so that they may be able to understand the things better and fetch them into their activity. To provide knowledge about green computing to students the paper presented some of the following ideas that may help them to increase their knowledge in the context of Green computing.

a. Include in Schools and University curriculum:

In order to increase knowledge of student s of IT about green initiatives and computing, colleges, institutions and universities must include green computing policy and terms of using computer into university syllabus curriculum. Because due to lack of proper knowledge students are not capable to take green initiatives in their daily practices so it may be good efforts towards increasing knowledge of students. It should be first priority of education department that green computing or how we can use computing devices with no or minimal impact on environment.

b. By calculating CO2 generated by our activity: Actually many of the students don't know about amount of CO2 generated by their routine activity. Due to lack of proper knowledge they do not know how CO2 effects the global warming and overall environment. It is necessary them to know about the procedure of calculating CO2 generated by different tools. An amount of carbon dioxide generated by an organization, institution or by an individual that released into an atmosphere is referred to carbon footprint that can causes by E-waste, fuel, electricity, server, data centers, internet requirements, cooling equipment's etc. It is possible to completely destroyed CO2 from atmosphere but a one can control their carbon footprint by controlling their activity and by knowing the amount of CO2 generated by activities and devices. An individual does not know about Generated amount of CO2 by products such as light bulb (100wt, 4 hrs.) emit 172g CO2, Mobile emit 189 gram CO2, even Google search produces 0.2 gram CO2 [Online src: https://clevercarbon.io/carbon-footprint-of-common- items/], Video streaming produces on average 135g while Facebook generated 13.5g CO2, carbon dioxide generated per hour by YouTube is less than Netflix streaming which is estimated by 1.6kg by watching it 30 minutes [Batmunkh A. 2022].

In order to calculate carbon di oxide emits by internet users or computer users, first electricity intensity are calculated and then energy impact. Then it should be converted into carbon di oxide. After finding CO2 in kg/Kwh, multiple by total number of users [Batmunkh A. 2022].

$$Energy\ impact(kWh) = Time\ spend\ on\ the\ internet\ action(min) \times Device\ Impact + data\ size \times (Device\ impact + Network\ impact)$$

$$\text{Electricity intensity is measured as kilowatt-hours : } kWh = \frac{Watts \times time\ (hrs)}{1000}$$

$$\text{Weighted Average : } \frac{\sum_i^n (xi \times wi)}{\sum_{i=1}^n wi}$$

India is the world's largest energy consuming country that pledges to achieving net zero emission by 2070 [India Energy outlook, 2021] that means balanced or remove carbon from environment by every activity in order to make India carbon neutral country.

C. Green Computing Practices:

According to literature study it is realized that awareness and knowledge of green computing among students can be seen at some scale but still students are not taking it in their practices. It is necessary to adopting green computing in daily practices. The presented here some key factors that can help students to achieve green computing in practices.

a. To Follow Energy saving steps:

If a one can try to adopt green guidelines and energy saving steps while working with digital devices or computer they may be give their huge contribution to prevent environmental damage by IT. Some computer devices such as desktop PC, CRT Monitors, XEROX Color cube 8570 color printer have high energy usage, so computer user should avoid to use a product and if possible turn them off while not in use. Some of the following steps are required for students to follow in order to adopt green guidelines while purchase, design, use and dispose computing devices and other electronic component:

- Use and purchase only EPEAT registered electronic product.
- Always preferred energy star qualified product.
- Shutdown PC and associated peripherals while not in use.
- Use storage area network as possible.
- Promote green and energy efficient computing.
- Consider reliability of hardware and software.
- Design to fit [Green Computing Guide, 2019]
- Practicing formal disposing.
- Encourage sustainable development of products.

b. Sustainable practice with dedication towards environment protection:

It is known that it is not possible to make large changes with a single effort and in a few days, but if a one can want to achieve something, dedication from his side is must. A single step of a person can bring big changes towards sustainable practices and activities. If students have knowledge and awareness about environmental issues, they should try to prevent environment by following the rules mentioned above but we have to promise to ourselves to keep environment healthy and carbon free. A one should dedicate towards their way of using computing devices and other associative devices. All students must try to do computing in environment friendly and sustainable way so everyone can contribute to save environment and natural devices for future generation.

VI. CONCLUSION AND SUGGESTIONS

Green Computing is necessary term for current and future generation as per rapidly growing requirement of digitalization. To keep environment protection as first priority the paper presented a suggestive model that can be applicable among students in order to increase their awareness, knowledge and practices towards green computing. The model provided some important suggestion in order to increase awareness, knowledge and practices among students at academic level. Above discussed suggestions will prove helpful for students while computing and internet surfing with minimum impact on environment and natural resources. With the study it is concluded that if awareness and knowledge level of students towards green computing will be increase, then definitely every IT students will be able to bring effective and efficient computing in their routine practice.

In parallel, it is recommended that Universities and higher schools should include green computing as a major subject in their curriculum. This subject should be part of students' study so every student will be more aware and knowledgeable in direction to go green. Universities and institutions can raise the level of awareness about green computing by implementing this presented suggestive model in order to prevent environment and increase use of eco-friendly computing. It is now a big responsibility of university, schools and institutions to increase awareness and social responsibility among students. More studies and suggestions are requires to increase level of knowledge and practice of computer users to take green initiatives.

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