



Green IT Curriculum: A Mechanism For Sustainable Development

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Abstract

This research, which proposes that environmental issues should be integrated into the Information Technology (IT) Education in Botswana and Botho University is presented here as a case study. Green Computing or Green IT like other global green initiatives has generated massive interest the world over. The importance and growth of Green Computing is evidenced by the sharp rise in international conferences on the subject, introduction of Green Computing courses in many developed countries such as Canada, USA and United Kingdom and incentives for graduates with Green Computing qualifications/knowledge. Despite this growing trend ‘to go green’ in the IT industry, countries like Botswana and the rest of Africa are still behind as confirmed by the lack of Green Computing courses in Universities (or any level of education), and very few conferences on the subject. A research titled “Green Computing: Students, Campus Computing and the Environment-A case for Botswana” (Batlegang, 2012) was conducted to measure the Green Computing awareness levels and capture any green initiatives at Botho University (then Botho College) and gives further impetus for this research proposal as it established that the levels of Green Computing awareness at the university are low and that there are minimum green initiatives. This research proposal aims to establish prudent means of integrating Green IT into the computing curriculum at Botho University.

Key Words: Green Computing, Curriculum, Sustainability

Introduction

The research proposes that environmental issues should be integrated into the tertiary education in Botswana and Botho University, which is presented here as a case study. Botho University is one of the leading private tertiary institutions in Botswana. From the time Botho University was allowed degree awarding powers in 2012, many programmes have been developed such as; Diploma in Computing, Professional Diploma (Honours) in Computing, Bachelor of Science (Honours) Computing, Post Graduate Diploma in Higher Education and Masters of Education in Higher Education. As Botho University moved towards becoming an independent degree-awarding institution, there was a need to revamp their academic structure to better manage the increased responsibility of curriculum and assessment development, service delivery, research, and quality management.

Unfortunately as Botho University made progress in developing various curricula for new programmes, there still remains an omission of a much needed Green Computing curriculum. Batlegang (2012) established that the awareness level of over 4000 computer users at Botho University with regards to Green Computing is low. The research also established that generally the green initiatives at Botho University are minimal. This research proposal aims to establish prudent means of integrating Green IT into the computing curriculum at Botho University. The development of Green Computing programmes/curricula will ensure that the awareness levels of students and staff are elevated. It is important to educate students in environmental responsibility throughout their education. In order to achieve a change of attitude, repetitive themes of Green Computing can be introduced especially in hardware and network oriented courses. The course on Green Computing should also be made compulsory so as to ensure that all students at the University are educated about environmental responsibility. The course will inform the students on the dangers of ICT equipment and also provide strategies on how the dangers can be mitigated (Tedre, Bangu and Nyagava, 2009).

Literature Review

Siegler and Gaughan (2008) define Green Computing or Green IT as “information technology and system initiatives and programs that address environmental sustainability”. Agarwal, Goswami and Nath (2013) concur with the above definition as they define Green Computing as “the study and practice of using computing resources in an eco-friendly manner in order to tone down the environmental impacts of computing”. The continued growth of Information, Communication and Technology (ICT) rises sharply by the day as computers are used in educational, commercial, corporate, banks and government sectors all over the world.

- In business computers are used for organization, self-sufficiency, reducing costs, increasing transaction speeds and managing sales.
- In the academic world, computers are used for teaching and learning for example the use of powerpoint slides, use of virtual learning platforms such as Blackboard, YouTube videos and other online learning facilities such as digital libraries and Google.
- In medical industry, records are kept using relational database management systems such as ER Medical, Open MRS, SQL Server databases, Oracle databases etc. while life support systems all run using computers. Ground breaking research in this field has also been greatly enabled by computers, while patients' visitors can access visit schedules online.

The above are a few examples of how computers continue to influence our lives and make them easier. This rise in computer usage means that computers also contribute to the rising cost of energy, depletion of natural resources as more and more computers are

manufactured and associated peripherals such as printers and paper are used. This generally has led to increased concern for the environment and growing interest in Green IT. There has been a growing number of Green IT conferences and curricula being introduced to schools and universities all over the world. The essence of these conferences is to share techniques for improving energy efficiency and reducing e-waste that maybe generated from the time computing equipment is manufactured, during its use and ultimately when it is disposed. The curricula serve to sensitize the end users on various means of using computers in a sustainable manner (Sobbota, Sobotta and Gotza, 2009).

The use of computers ought to be optimum given its importance in the world today. Bello, Badariah, Ahmad and Nordin (2013) argue that users must be given the knowledge of proper utilization of computers e.g. computers should not be used unnecessarily and should not be left on when unused. Reuse and recycling must become integral part of sustaining computers and prolonging the lifespan of computers. Disposal should be the last resort. Companies must use e-resources instead of printing so as to reduce the carbon dioxide emission footprint. This knowledge must be incorporated into each individual and universities can be seen as a starting point if no prior knowledge regarding this matter exist. If this knowledge exists eco-friendliness can be maintained.

Methodology

Research Objectives

It is envisioned that the development of a Green Computing curriculum will educate end users about responsibility to the environment throughout their education. At the end of this research work the following objectives must be met:

- To develop a Green Computing curriculum that will develop users' knowledge and understanding on sustainable access to computing and networking resources.
- To highlight how existing computer technology can be used for sustainability in other fields of studies.
- To ascertain how a Green Computing qualification or certification can be used as an incentive to students who have successfully completed the programme and to the employers who stand to gain in hiring environmentally aware/sensitive graduates.

Research Questions

This study is focused on coming up with a Green Computing curriculum with an aim to raise awareness levels of computer users at Botho University. The research seeks to answer the following questions:

- How can a Green Computing curriculum be developed so as to develop user's knowledge and understanding on sustainable access to computing and networking resources?
- Can existing computer technology be used for sustainability in other fields e.g. Business, Accounting and Education?
- Green Computing certification/qualification; how can it be used as an incentive for both students and employers?

Problem Statement

The impact of IT and computer systems on the environment is well acknowledged and recognised. As one mechanism to address lack of green IT awareness and lack of green

computing programmes at Botho University, the research proposes the need for a Green IT course which will cover inter alia the following themes; dangers of ICT equipment and mitigation strategies (e.g. consumption of electricity, electronic waste toxicity, correct disposal of ICT waste, pollution of environment by computer hardware and cleaning agents etc.), measurement of energy consumption/cost, reduction of carbon dioxide emission (CO₂e), local and international laws on environmental issues . In the end the Green IT curriculum will be evaluated to measure its effectiveness.

Purpose and significance of research

As already alluded, the main purpose of the research will be to study about how environmental issues can be incorporated into the already existing IT curriculum. It is envisioned that the development of the aforementioned curriculum if implemented will have the following goals/results:

- Making students aware of the dangers and seriousness of ICT-related pollution.
- The students will learn to understand the environmental effects of computing installations and to weigh the trade-off between those effects
- To instill in students the attitude that environmental issues are all about small choices they can make.
- Providing a measurable increase in the awareness level. The objective is that the awareness levels will have been raised to above 90% at the end of the Green Computing course.
- Providing measurable evidence of reduction of energy cost at Botho University.
- Reduction of total carbon dioxide emissions (CO₂e) by Botho University staff members and students.
- Providing a distinctive advantage for Botho University students with regards to their careers.
- Making students aware of local and international environmental laws and regulations (Tedre, Chachage and Faida, 2009; Batlegang, 2012)

Studies such as (Sobbota, Sobotta and Gotza, 2009) have shown that companies, organizations and governments that are not implementing Green Computing strategies use large volumes of energy but we have to be mindful of the fact that there is insufficient green energy to meet the large demands of the ICT infrastructure hence the more energy consumed the high the impact on the environment due to the use of environment unfriendly energy resources (African Development Bank, 2009).

The significance of this research is that it has the potential of changing lives, not only at Botho University but lives of the entire Botswana population. In order to fully reap the benefits of Green Computing the changes in behaviour have to be a collective responsibility. The more the people respond positively to the program and implement what they have learnt the greater the impact. The project will be an important contribution to the education curriculum in Botswana which currently lack Green Computing programmes.

Sample

The research methodology was designed such that the required data is gathered from the following groups: university students and graduates, lecturers & university management, and industry representatives. The sample consisted of 224 students and 56 lecturers from Botho University, a private university in Botswana. The sample also consisted of 40 alumni

of the same private university. In addition, 10 university management representatives formed part of this research study. A further 25 respondents came from industry representative with a bias towards ICT. The total of the sample was 355 respondents which constituted 70% of ICT related domains and 30% non ICT specializations. The respondents were selected using a combination of random and purposive sampling techniques. The diagram below shows the major categories of the research participants.

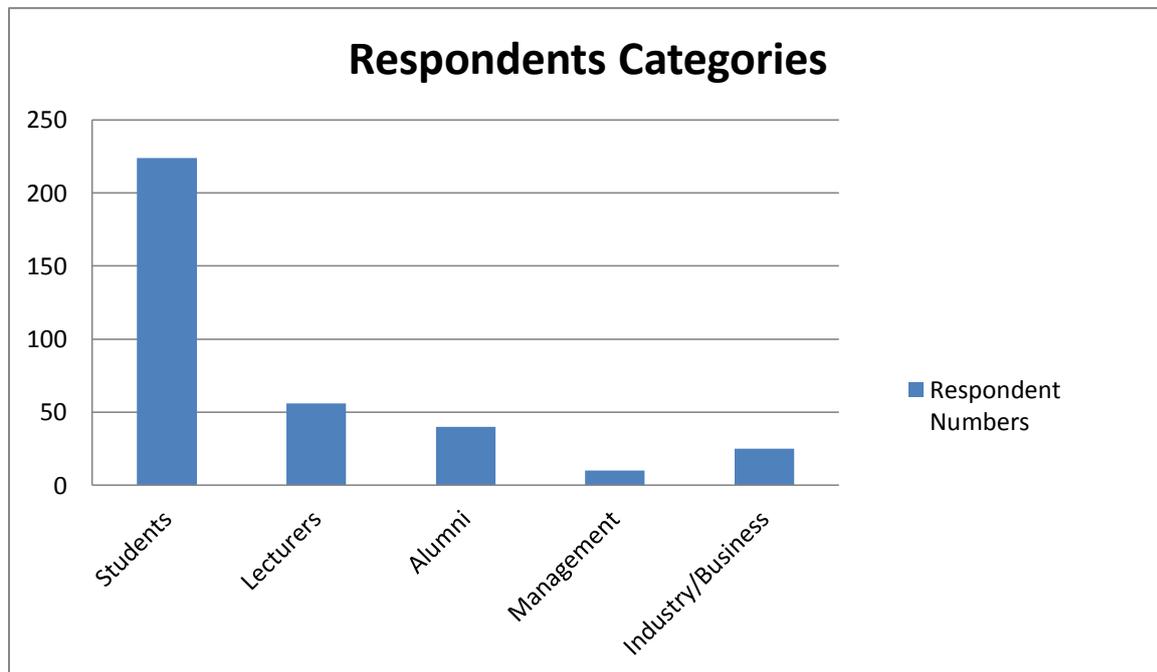


Figure 1: Respondent's categories

With regards to gender, 45% were female and 55% male as shown in the diagram below.

Gender

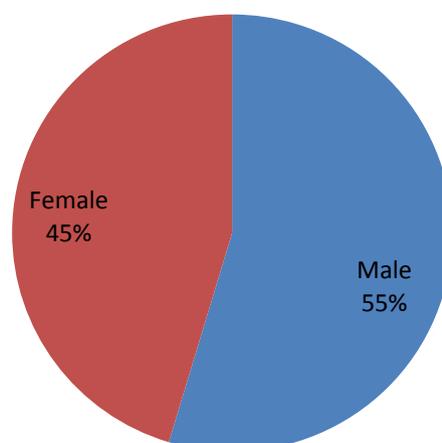


Figure 2: Gender ratio

In order to extract the required data, consultations with the above groups was done through questionnaires, discussion groups and individual interviews. The questionnaires were administered by hand and also through e-mail. A couple of follow-up measures were employed such as paying a visit to the respondents (office visits especially to the lecturers and management), e-mail reminders and making phone calls. This was done in order to achieve a high response rate. It should be noted that out of the 450 questionnaires sent out, 355 usable questionnaires were returned constituting a 74% response rate.

Research instrument

The researcher developed a questionnaire (see Appendix A) that constituted 2 sections: Demographic data in Section A and Green Computing Curriculum Data in Section B. The demographic data section of the questionnaire was used to collect information such as the age, gender and familiarity with Green Computing concepts. Section B of the questionnaire was used to extract information on the Green Computing curriculum such as the suitable modules to include, how to integrate the Green Computing curriculum and ascertain how a Green Computing qualification can be used as an incentive to both graduates and employers who stand to gain in hiring environmentally aware employee. E-mail interview questions were also generated and sent to industry experts, management and IT lecturers. The interview questions asked participants about things such as module sequence, milestones, number of credits and notional learning hours of each Green Computing module. Further, semi-structured interviews were conducted by telephone and in rare occasion in person to obtain an in-depth understanding of the participants' perception on Green Computing curriculum and their experiences of sustainability issues in general. After data/items were generated, they were subjected to validation by ICT experts and then pilot tested on a representative sample of the target respondents. The reliability of the study was high on average at $\alpha = 0.93$.

Data Analysis

The research data were analyzed to understand how Green Computing curriculum can be integrated into an existing curriculum, and how the existing systems can be used more effectively as well as establishing how a Green Computing certification can be used as a motivation for both students and employers. The analysis was done by the researcher, who followed several steps in analyzing the data. The first step was to ensure that all the data is written data and as such, all telephonic interviews were transcribed to produce data for analysis. This process was done manually by the researcher. Once this stage was completed, the researcher read and re-read all the written interview responses to have an in-depth understanding of what the respondents were saying. This new found data was interweaved with already existing questionnaire data to make sense of the entire direction of the research. The researcher then did open coding to mark participants' responses with regards to a) topics to be included in the Green Computing curriculum, b) notional learning hours and credits for the course, c) how the Green Computing certification can be used as an incentive for both students and employers. From the open coding, the researcher developed preliminary categories which were based on the respondents' narrative. From the open coding, the researcher used a combination of axial and holistic coding to further analyze the data. With axial coding, the researcher made an attempt to make connections between the preliminary categories (from open coding) and developing new, more abstract categories with structural variations. The chief aim of this coding was to find similarities and differences between the categories with the aim of further grouping similar concepts. The holistic coding was used to look at the most frequently used keywords and key terms (e.g. energy saving, cost cutting, recycling) in the interview questions and questionnaire responses. To conclude analysis, the

researcher identified themes related to the research questions and looked for relationships to the key concepts of Green Computing curriculum integration and associated the resultant themes with the literature reviewed.

Discussion of results

Results against research question 1

The first research question asked was “How can a Green Computing curriculum be developed so as to develop user’s knowledge and understanding on sustainable access to computing and networking resources?” What follows below is the response to the above question. A percentage analysis of the respondents shows that 86.5% of respondents want Green Computing Curriculum to be introduced at Year 1 of university study. A further, 67.8% want the modules of the Green Computing course to be spread across the 4 years of study.

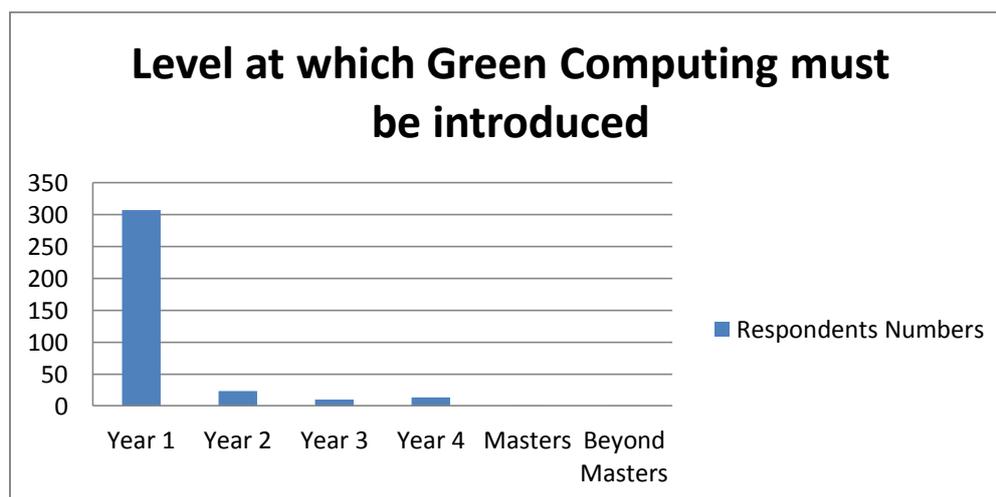


Figure 3: Year at which Green Computing curriculum must be introduced

A further 67.9%, which was 241 respondents want the modules of the Green Computing course to be spread across the 4 years of study. The respondents gave reasons for spreading the modules across the four year degree programme. Please see the diagram below too see the distribution of the yes and no.

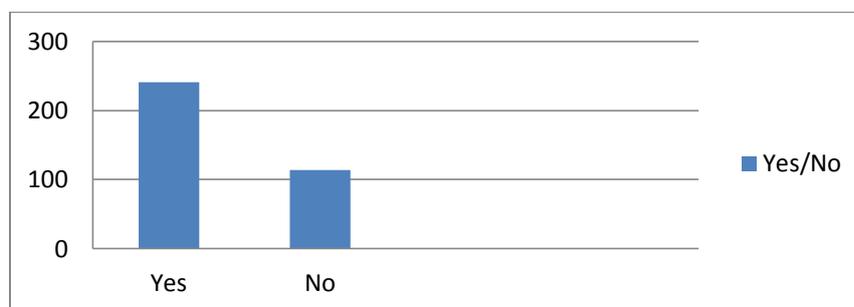


Figure 4: Yes / No

Regarding the first research question, the research also established that from the given set of modules/subject for the course, the respondents were happy with the selection of the topics. The table below gives results of the questionnaire regarding the fourth question which

looks at the modules that can be added to this course. Below the table is a diagram showing the same information.

	No Opinion	Very Unimportant	Fairly Unimportant	Fairly Important	Very Important
Green Computing Fundamentals	0	0	0	0	355
Regulations and Industry initiatives	0	0	0	4	351
Power management and saving	0	0	0	1	354
Material recycling and waste management	0	0	0	0	355
Education and certification	0	0	0	0	355

Table 1: Modules

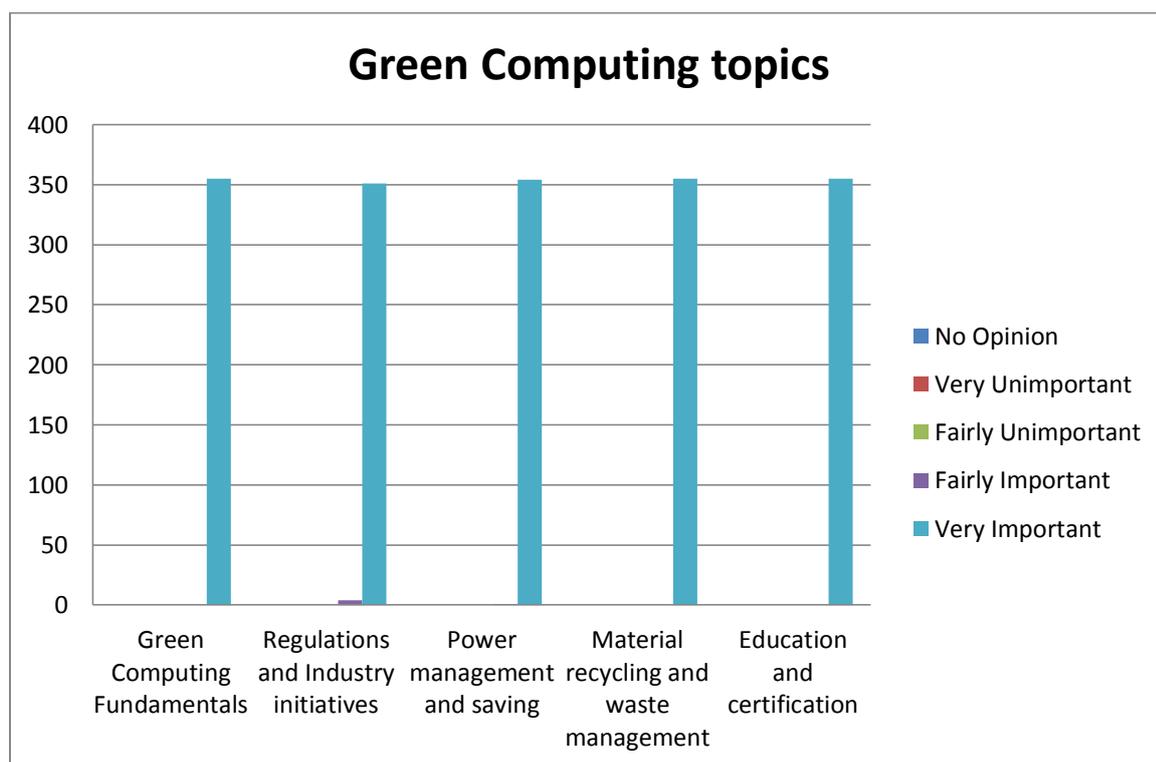


Figure 5: Green Computing Subjects

To conclude on research question 1, the participants of this research believe that it is important to integrate the Green Computing curriculum into the existing curriculum. The participants also gave recommendations that the programme should be integrated into all degree programmes at the private university being used as a case study. They also suggested that, a shorter version of the course can be developed as part of the short programmes that can be run under the Corporate Training department at Botho University. Interview, especially with Industry/Business experts gave valuable feedback on the number of credits that can be allocated for the course. They suggested that when integrated into the degree programme, the course should be allocated 20 credits, meaning that 200 notional hours of study is required to

successfully complete the module. For the short programme, they suggested that this could be a 3 credit course that can be completed in 30 hours.

Results against research question 2

The second research question reads as ‘How can existing computer technology be used for sustainability in other fields e.g. Business, Accounting and Education?’ In order to answer that question, the researcher engaged with the IT lecturers, Industry/Business experts and management. The following were some of the responses from the respondents:

‘...The goal of green computing is not necessarily to come up with new interventions but to use existing technologies in a sustainable manner. This means that other faculties also need to be taken onboard and taught for instance, the negative effects of unnecessarily printing of files and e-mails which can lead to lots of paper waste which means more chopping down of trees!’

‘Procurement officers in the relevant departments or faculties must be trained about purchasing energy efficient equipment with energy star logo. Furthermore, the procurement officers must be trained to only purchase from dealers that espouse socially responsible environment selling and procurement of computers.’

Some participants gave tips on how projectors can be used for projecting instead of giving out handouts; switching computers and associated devices such as projectors, air cons etc when they are not in use. Some suggested that the university must define a Green Computing policy that includes recommendation of reuse before recycling, define a recycling program, and green procurement. The structured interview questions and semi-structured interviews helped to generate this type of data.

Results against research question 3

The third research question reads as ‘Green Computing certification/qualification; how can it be used as an incentive for both students and employers?’ Most of the respondents who were asked this question did not give concrete answers as to how the Green Computing certification can be used as an incentive for both students and employers. However, 63.6% of the participants who answered the interview questions indicated that though at the present moment, Green IT qualification is not a requirement for employment in Botswana, in future those who possess the qualification might be at an advantage. The Industry/Business experts who answered the interview questions also affirmed that, they will definitely give preference to hiring an employee who is well versed in Green IT and general sustainability issues than an individual who does not, and definitely the certification will validate individual’s competence.

Conclusion

This proposal attempts to bridge the gap that exist in the education system in Botswana and Botho University is used as a case study. Fantastic programmes in Computing, Business, Finance, Accounting, Hospitality etc. exist at Botho University but there is a grave concern that despite the obvious increase in energy consumption due to increased ICT usage as well as overall negative impacts of ICT hardware and carbon dioxide emission on the environment, little or nothing is being done to sensitive users on the effects of ICT equipment and peripherals on the environment. This proposal aims to develop a Green Computing curriculum to deal with issues of raising green IT awareness to computer end users as well as educating on environmental legislation and preaching the incentives for both students and employers who are green conscious. The research established prudent means of integrating Green IT into the existing curriculum as well as establishing how existing IT infrastructure

can be used in other domains in a sustainable manner. Lastly the research established how a Green IT qualification can be used as an incentive to both employers and graduates.

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Appendix

Paper Title: Green IT Curriculum: A Mechanism For Sustainable Development

You are invited to take part in a research conducted by Billy Batlegang from Botho University Botswana. The aim of this research is to come up with a Green Computing curriculum that will educate computer users about sustainable use of computers and about their responsibility to the environment throughout their education. This research also seeks to highlight how existing computer technology can be used for sustainability in other fields of studies. The research will also ascertain how a Green Computing qualification can be used as an incentive to both students and employers and in the process raising Green Computing awareness in the academia and industry.

Your participation will involve answering the questionnaire that follows in relation to the research described above. Your participation in this research will contribute towards the possible integration of Green Computing curriculum in Botho University and other institutions worldwide which may be having interest in Green Computing.

Your participation in this research is really appreciated and any queries about your participation in this study may be directed to the following:

- Researcher Name: Billy Batlegang
- Cell: +267 76135513
- Email: billy.batlegang@bothouniversity.ac.bw

SECTION A: DEMOGRAPHIC DATA

1. Please indicate your gender with a tick (✓).

Male Female

2. Please indicate your age group with a tick (✓).

Below 20 20-30 31-40 41-50 Above 50

3. Please indicate whether you are a student or not with a tick (✓).

Student Not a student

4. If your answer to question 3 is 'student' please indicate with a tick (✓) the level of your study.

Undergraduate Postgraduate

5. If your answer to question 3 is 'not a student' please indicate with a tick (✓) a category below that best describes you.

Unemployed Employee Employer

6. If your answer to question 5 is either 'employee' or 'employer' please state the industry you are in e.g. ICT, Education, Public Health

Industry _____

7. Please indicate with a tick (✓), your familiarity with Green Computing (or Green IT) concepts

Not at all Familiar Somewhat Familiar
Moderately Familiar Very well Familiar

SECTION B: GREEN COMPUTING CURRICULUM DATA

1. At which level of study must Green Computing Curriculum be introduced at university education? Please tick (✓) the appropriate box.

Year 1 only

Year 2 only

Year 3 only

Year 4 only

Master’s level only

Beyond Masters

2. Should the Green Computing concepts be taught in all the years of a bachelor study (Year 1 – 4?) Please tick (✓) the appropriate box.

Yes No

3. Please give reasons for your answer in question 2.

4. How important is it to include the following topics/modules into the Green Computing curriculum? Please tick (✓) the appropriate box.

	No Opinion	Very Unimportant	Fairly Unimportant	Fairly Important	Very Important
a. Green Computing Fundamentals					
b. Regulations and Industry initiatives					
c. Power management and saving					
d. Material recycling and waste management					
e. Education and certification					

5. In your opinion what is the best way to integrate Green Computing into an existing curriculum? Please tick (√) the appropriate box.

a. Teach as an independent short programme _____ 1

b. Integrate the module into the existing programme i.e. as part of the undergraduate studies

_____ 2

c. Integrate the module into the existing programme i.e. as part of the postgraduate studies

_____ 3

d. Other (please specify) _____ 4

6. Please indicate with a tick (√)

	No Opinion	Very Unimportant	Fairly Unimportant	Fairly Important	Very Important
a. Is Green IT certificate important?					
b. Should Green IT certificate give graduate an advantage?					