Journal of Engineering and Applied Sciences 11 (12): 2662-2667, 2016
ISSN: 1816-949X

Proposals for Green ICT Campusthrough M-Learning in Malaysian Higher Education Institutions

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Abstract: Mobile computing is under rapid development process and reached a stage where it is all set to replace the traditional computing of so called "work station" based operation. Malaysian Higher Education Institutions are aspiring to achieve Green ICT Campus as a commitment and responsibility for the Society and the Environment. This paper is about studying the current practices in Malaysian Higher Education Institutions and proposing various scenarios in making the campus as a Green ICT Campus through Mobile-Learning.

Key words: Mobile learning, green ICT campus, green computing, commitmen, responsibility

INTRODUCTION

Mobile computing technology from the initial stages of being useful for the scientific and defense community has been developed into many stages of daily activities including the University campus for learning purposes quite long time ago. Mobile Learning (M-Learning) is defined as "learning across multiple contexts, through social and content interactions, using personal electronic devices". Now a days, teaching and learning depends almost entirely on computers with the latest technological advancements. Mobile devices such as Smart Phones, PDAS and Tablets etc. with their high speed connectivity and features are revolutionizing the learning and teaching at universities with the flexibility and mobility (Darren *et al*., 2015). The last two decades had seen rapid development in ICT including Mobile computers. The Smart Phones are gaining more popularity and in most of the times, they are replacing computers at home and office for day to day tasks. Whether it is a Lap top or a Smart Phone or a Smart watch on the wrist, this development is growing without boundaries. M-Learning allows students to not only to learn effectively with the use of technology but also helps in terms of learning flexibly at their own pace beyond class room (Virvou and Alepis, 2005). Blending information technology in education has made the learning process enhanced and refined in the formal classroom setting. In addition, mobile technology has an extended flexibility of learning outside and beyond classrooms with a capacity of enriching the context in the entire learning process. The current aspects of technology, information age, faster access to the application and data assisting the learning methods to soar new heights without compromising any pedagogical skills that are required for learning within a classroom. The influence of mobile devices on higher education and their impact on lifelong learning opportunities is growing in modern tech savvy community of learners and the teaching staff. Whilst reaping the benefits of M-Learning, new methodologies are proposed in this paper for the possibilities of being environment friendly and how M-learning could assist the Malaysian Higher Education Institutions (HEI's) to achieve Green ICT Campus.

The mobile use and its statistical information: Since, past one decade, the number of people using mobile phones and Smart Phones are growing rapidly. According to Collate School of Business, 91% of the US adult population currently owns a Mobile Phone and from that 61% are Smart Phones. It is expected that, 1 billion Smart Phones are expected to be sold in the coming year which is almost double to that of the number of personal computers (UAB, 2016). Ten billion mobile units are expected to be available for mankind in 2016 for a population of 7.3 billion which means 1.4 devices for each person living on the planet. Mobile Apps are being installed in these devices and 68% of them are using Apps for various purposes including various aspects of day to day life, from searching information to commercial applications like Banking, paying bills and entertainment (UAB, 2016). Educational apps are not being seen as a popular category yet as the top 5 popular apps are search, social followed by entertainment, communication, productivity tools and commerce. However, the

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Educational apps has a high potential as the current tech savvy generation is spending more time on Mobile Phones than on face to face direct communication. Students from Malaysian HEI's are no different in terms of pro technology behavior. According to Malaysian Communications and Multimedia Commission (MCMC) statistics, in Malaysia, 86% of the population using Mobile Phones and 64% of them using it for internet access and 53% of them using Smart Phones. Students with their profession recorded as "fulltime student" contributed to 16% of the total Mobile Phone users in Malaysia. A staggering 97% of the population feels that Mobile Phone is important and very important in their life (Mra and Equipment, 2016). Smart Phone involvement in all aspects of human life from different categories has raised and occupying significant amounts of daily life than any other technical innovation in 20th Century. Malaysian HEI's too are emphasizing and moving towards M-learning eventually from the traditional methods of teaching and the pedagogy.

Green ICT Campus: Green computing or Green ICT is defined as "the practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems for reducing the use of hazardous materials, maximizing energy efficiency, and promoting the recyclability or biodegradability of products" (Arayalert and Nakata, 2011). Approximately, about 2 million students pursue their education in Malaysian public and private HEI's. It is not a surprise that the entire population at these HEI's including all the stakeholders resembles a populated town. The energy demands are different across various stakeholders in the community and any energy savings in any unit/division/department including ICT has direct contribution in reducing the overall energy demand as such due the size of this community.

This research study focuses and highlights the possibilities of achieving Green ICT campus through Mobile Technologies for Malaysian HEI's. Malaysian HEI's were involved in some environment friendly initiatives in the past. University of Malaya signed Talloiries Declaration along with >300 other universities from 40 countries who proposed for a 10 point action plan for achieving sustainable campus environment. There is some awareness and efforts are noticeable to achieve Green Campus among the Malaysian HEI's recently (Foo, 2013). But, there is still more to be done in terms of creating attention in the decision making authorities and the stake holders. Students from HEI's in Malaysia traditionally depend on desktops in the Institution or their personal notebooks for learning purposes (Darren *et al*., 2015). This is changing gradually during the learning processes while attending classes, students are depending a lot on their Smart Phones for recording the visuals of lectures and using PDA's and Tablets for academic related communications. In terms of energy consumption, another significant energy requirement is while staying connected to the Internet using the network cable at one location such as class room, library or laboratory which comes together with fixed energy requirements for air-conditioning and lighting. There are developments where the entire campus is Wi-Fi enabled and the process reduces the dependence on cable connection at a particular location.

When it comes to promoting Green ICT Campus, Malaysia is in the process of improving the facilities and moving towards green campus which includes ICT facilities. For instance, Ministry of Education, Malaysia is working with Google for adopting Google Apps which could reach a group of 10 million students, teachers, and parents. In addition, primary and secondary schools are receiving Chrome books to not only support the students, but also to the country's efforts to reform its educational system including improving attendance and graduation rates while enhancing the learning experience. This is similar to Google's support for hundreds of Schools in Philippines and in the US.

Google announced that 400+Universities are utilizing YouTube Edu to host lectures and full courses. The majority of Ivy League Universities and most of the top 100 Universities in US are using Google Apps for education and over 500 schools and districts are using Chrome books since 2013.

MATERIALS AND METHODS

M-learning layout: The proposed process for HEI's in Malaysia for switching to M-Learning from the traditional learning and pedagogy is shown in Fig. 1. To begin with, a detailed study on the current practices is carried out with the information of the energy consumption at various units and facilities through an energy audit. From the obtained audit findings, the possible areas for implementing the M-learning process, corresponding equipment and investment in short and long term is carried out for the HEI through SWOT analysis. The detailed process of M-learning process with SWOT analysis. Finally, the implementation need to be commenced step by step till the maximum benefits are obtained at each unit with the prospects for continuous improvement. Few of the proposals are discussed further subsections 2.2-2.5.

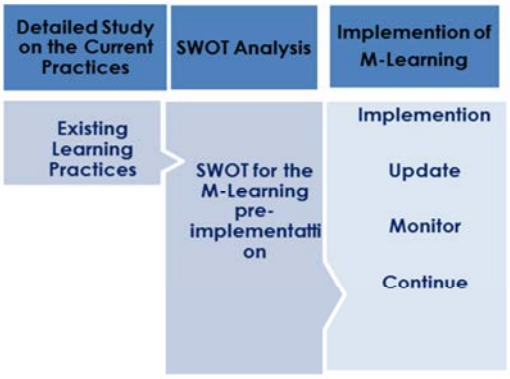

Fig. 1: M-Learning process pedagogy

Learning Management System (LMS): The learning management tools are best alternative for conserving energy compared to a traditional classroom learning with the flexibility of providing greater information resources with faster access and digital storage space along with the mobility. LMS is a long-term and permanent solution for a responsible, stable, technically advanced learning option.

SWOT Analysis matrix for M-Learning:

- Strength
- Stakeholders awareness
- Tech Savvy community
- Ease of communication
- Pro R and D culture
- Availability of resources
- Existing infrastructure

Weakness

- Resistance to change from senior staff
- Layers of bureaucracy
- Limited community
- Lack of cooperation among various departments

Opportunities

- Support from government
- Partnership from various GLC
- Technical awareness workshops
- Constant requirements for upgrade
- External grants
- Support from community outside campus

Threats

- Changes in senior management
- Lack of support from some sectors within
- Raise in equipment cost
- Administration members prone towards corruption

The learning management tools such as Angel, Blackboard, Canvas or Moodle assists the HEI's for all the flexibilities such as teaching, guiding the students, designing the assessment tasks, assessment management activities like releasing and submissions and conducting tests. In a nutshell, everything that is available in traditional learning turns into online and mobile with vast and unlimited resources which is the key for M-learning. Blackboard established good partnership with Institutions to build a better educational experience in new ways in the classroom and beyond. University of Leicester in UK, Wilmington University and Cleveland State University in the US are already using Blackboard Mobile Learn App for their Students.According to Cleveland State University, The average user using Mobile Apps spends 9% more time than accessing the internet. Android and iOS users spend over 81 min on mobile applications each day. The University believes that, eventually Mobile Phones will overtake PCs as the most common web access device worldwide. Their studies during a pilot study at the end of the semester reveals a higher passing rate of 16% using Sprint 3G Samsung Galaxy Tablets with Blackboard Mobile Learn tool. Only 10% of the students dropped the class, against 13.3% of other sections. Also, 53% of students are on the higher side of satisfaction with Blackboard Mobile Learn which made instruction more accessible using Sprint 3G Samsung Galaxy Tablets. Moodle enhanced their systems to be available on cloud which can be considered as greater contribution towards Green ICT. The data reveals that Moodle is gaining popularity in smaller Institutions which registers less than 800 admissionsper year.

Some of the salient features available in LMS are conducting classes online, able to watch other lectures in the same field, providing study materials, releasing and submitting assignments (including plagiarism detection), communication and cooperation, instruction and guidance and conducting assessment. All these data can be on cloud contributing to Green ICT on Campus. It is envisaged that, for Malaysian HEI's too, lesser dependence on conducting the classes on campus reduces the energy requirements as per the sample energy consumption shown in Table 1 for each venue in the HEI.

Library e-management: Library management tools assists the cataloging, distribution and maintaining the records on lineas the richness in knowledge requirement has changed the accessing methods in retrieving key knowledge and relevant information. Majority of the Malaysian HEI's are providing access to the resources online by subscribing for online Journals and eBooks.

Library management tools supports the availability and distribution of Library resources information with a mouse click without even visiting the Library.Global Library technology industry aggregate revenues reached around $1.8 billion in 2013 itself. Library Apps are gaining popularity on Android and iOS for the Mobile Phone users and the popularity is growing with the transition to cloud computing and Software-as-a-Service (SaaS) guiding the traditional library management towards M-Learning. The number of hours students need to spend in the Library reduces considerably with the implementation of these applications for Malaysian HEI's. The reduced energy consumption at Library can be calculated as per the energy demand is explained in detail in results section.

Wi-Fi: Malaysia enjoys 67.5% of Internet penetration as of 30th November 2015 for the 30 Million population which is considerably high compared to the other Countries in the region such as Thailand, Indonesia, Sri Lanka, India and China (Muniandy, 2000). However, Malaysia has been ranked behind Sri Lanka and Thailand in average Internet speeds in 2015 second quarter report. A study conducted in University Science Malaysia for Undergraduate students in 2010 revealed that all the 100% students felt the Internet connection is useful with the flexibility of learning at any time for their studies. A better, stable Wi-Fi connection adds more value for their learning at their own pace and convenience. Wi-Fi connection is available at almost all the HEI's in public and private sector in Malaysia with the speed and connectivity variations across its campuses. It is proposed that more stable and high speed Wi-Fi connection promotes M-Learning which is directly linked to promoting Green ICT Campus. Communications, conducting tests, lab simulations which are part of LMS as explained in 2.2 above in certain subject areas are benefited with the reliable Wi-Fi connection and the corresponding energy demands for each facility are as explained in Table 1.

Mobile apps: Mobile educational apps are gaining popularity among Malaysian Students too in each and every aspect of academic life cycle such as Time table Apps, Library books Apps, Examination Apps, Citation Apps, Learning management Apps and Career advising Apps. The salient features of the Mobile Apps are: simple in operation, mobile, quick and easy access, and easy to use. Most of the Apps are open source, available for free and gets updated with latest features regularly.

Table 1: LMS popularity usage popularity data for higher education institutions with >2000 enrolments

Variables	Angel	Bb Learn	Canvas	Moodle	Other
INST	123	817	232	339	201
2014	6.4%	42.2%	12%	17.5%	10.4%
Method 2013	6.1%	40.2%	11.4%	16.9%	9.9%
Enrollment	809,654	7,192,050	2,283,841	2,454,569	1,856,040
	5.1%	45.7%	14.5%	15.6%	11.8%
Average size	6583	8803	9844	7241	9234
Median size	4552	5583	5828	3723	3592

McGraw-Hill Education conducted a survey among the University Students in 2015 and found that 77% of students told that using technical gadgets such as Tablets and Smartphones has helped improve their grades and 62% said that technology helps them feel more prepared for class (No-Cost Blackboard Mobile Learn and Cleveland State University, 2016). LMS for the HEI's could integrate with Sharable Content Object Reference Model (SCORM) from both client (Student) and server side for effective customized Apps. At the same time, HEI could advise and encourage their Academic team to guide the Students and develop Apps that are application specific to their environment. By doing so, both the academic team and the students are able to update and impart their skills to the community. In terms of applying the measurement of the effectiveness of Apps for each of the application, energy demand per unit and a sample energy demand is calculated in the results and discussions.

RESULTS AND DISCUSSION

The points from 2.2-2.5 indicates various strategies and tools that could be deployed for optimum energy consumption at Malaysian HEI's to move towards Green ICT Campus. To study the effects of these strategies, detailed experiments are conducted using M-Learning on two HEI's in Malaysia which are University College Linton and Pertama Institute of Technology. The experiments were conducted with 200 participants in total, 100 from each institution with 50 students and 50 staff. These participants are selected to represent course, field of study, year of study, race, religion, financial background, details of mobile device they hold, number of hours that mobile device is being used in a day for academic purposes, familiarity with the latest technology, Using Apps etc. The sample energy consumption for the two HEI required is shown in Table 2.The amount of energy consumed is calculated per each learning hour per class is shown in Table 2.

Classes in Malaysian HEI's are separated into theory, tutorial and practical sessions. The centre for

Table 2: Energy requirement for the equipment in the class

Appliance	Rating (W)	Per month KWH	Class Unit H^{-1} (25 working days, 8 h day)	Total energy Used (Kwh)
One and half ton AC	1000	60.0	0.30000	0.3000
Fan (Ceiling or circulating)	45	13.5	0.06750	0.2700*
Fluorescent Tube	32	28.8	0.14400	1.15200**
Computer	120	3.6	0.01800	0.5400***
Mobile gadgets	3	2.0	0.00012	0.0025

Environment, Technology and Development, Malaysia (CETDEM) has provided the standard energy consumption for the various Appliances. Energy requirement for the two Malaysian HEI's are calculated using the principle of CETDEM, for a standard class of 30 students, the energy required for theory and tutorial will be at 2.1 kWh and for practical it will be at 3.7 kWh. If the class is replaced with the help of mobile technologies and the learning process is conducted digitally without the physical presence inside the classroom, the energy saved is directly proportional to the reduction of Carbon Foot print and to the Green ICT. After conducting the class successfully for one cycle, these benefits of learning patterns could be implemented further as per number of students and classes across the HEI.

The detailed mobile data usage results of the two Malaysian HEI's are as shown in Fig. 2. It has been found that 100% of staff and Students are using Mobile Phones, in which 83% students and 67% staff are using Smart Phone. Though the usage of Apps from both the categories are below 50% at the moment, the interesting factor is that they would prefer mobile technologies in and out of the Campus and for administration activities too. University's awareness and investment are captured and shown in Fig. 3. Figure 4 shows the encouragement from individuals to the senior management, Government's support and most importantly 90% and above of them felt that there is more to be done for Green ICT in Malaysia as compared to Western Countries.

The Same energy calculation for a different requirement could be applied for other departments such as library, laboratories and other units. The energy requirement for individual application usage off campus is also calculated. For example, consider a Mobile App for a tutorial topic for assisting students which is scheduled as a normal class. When all the students complete the task through the Mobile App, the energy saved for conducting the same class physically is comparatively huge in volume.

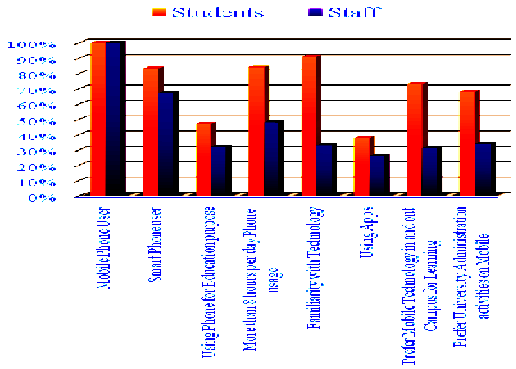

Fig. 2: M-Learning feedback from the two HEI's community mobile device usage

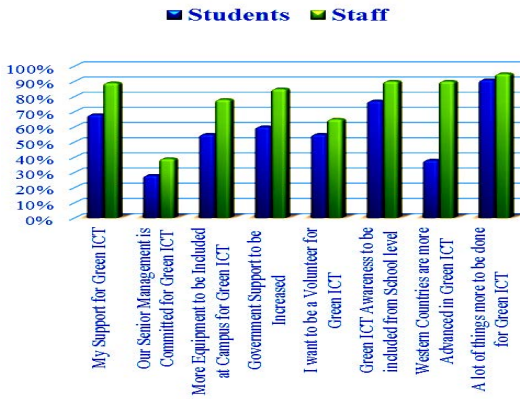

Fig. 3: Feedback on administration for green ICT HEI's commitment towards M-Learning

A typical Mobile Phone charger is rated at between 3-7 W for fully charging (Standby power summary table, 2016). That means, for the 2 h charging, it will consume 0.006-0.014 kWh of electricity. Assume 0.010 kWh average consumption, and for a 30 member class, the total consumption is 0.3 kWh. Now, this is brought to one of the typical class room setting in Pertama Institute of Technology's (ITP) class which is selected for experiments.

In ITP, each class room is fitted with one 1.5T Air conditioner, 8 Fluorescent Tubes, 2 Ceiling Fans and 31 Computers, the energy consumption according to Table 1 is shown in Eq. 1:

$$\{(0.3)+(8X_0\times144)+(2X_0\times0675)+ (31X_0\times018)\} = 2.145 \text{ kWh} \quad (1)$$

For 2 h of class it is 4.29 kWh. This is almost 14.5 times more energy consumed for conducting tutorial class

physically against completing the task through the Mobile App. This is not including the transport and other building equipment energy consumption like lifts, communication time, effort for scheduling the class etc. This equation holds good for laboratory classes, theory classes and library according to the equipment fixed in the HEI and the corresponding solutions through Apps. As the HEI's are able to design their own Apps, they can customize the best App for their requirements. Based on the obtained results of two Malaysian higher educational institutions, it is concluded that more benefits could be achieved using Mobile learning in terms of energy consumption which enables the HEI to move towards Green ICT campus.

CONCLUSION

The importance of Mobile computing and how the Mobile technology could contribute to achieve Green ICT campus for HEI's in Malaysia. Mobile technology is the future and it is envisaged that the technology eventually replaces the traditional class room learning and allows the HEI community to spend more time on hands on, flexible learning which is contributing for Green ICT as well. With the implementation of Mobile Learning, there are some other aspects such as psychological effect and the intensity of face to face learning need to be studied in detail. The future research is towards finding more options for effective communications, smart mobile equipment where the total learning could become flexible and mobile. All the HEI's are requested to strive for making the campus and the community more green and remain green for the benefit of future generations.

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