International Journal of Engineering & Technology, 7 (4.38) (2018) 1012-1016

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Green ICT and Environmental Sustainability: Awareness of Malaysian Teachers

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Abstract

Green ICT that has been outlined by the Ministry of Energy, Green Technology and Water (KeTTHA) is seen to be important to balance the implementation of ICT in schools where elements of environmental preservation from inefficiency use of technology can be applied from teachers to students at the early stage. This study examined teachers' awareness of Green ICT and environmental sustainability in the aspect of teachers' knowledge, attitude and practices as proposed by the KAP Model. The sample comprised of 358 secondary school teachers. Descriptive statistics, independent sample T-Test, One-Way ANOVA and multiple regression were used to analyze the data. Result revealed that a most of the teacher lack of knowledge on Green ICT, but teachers' attitudes and teachers' practices found to be high. The important of knowledge gaps related to, and factors influencing the sustainability of attitudes and practices on Green ICT were identified and discussed.

Keywords: *Green ICT, Environmental Sustainability, Knowledge, Attitude, Practice*

1. Introduction

Most of educational institution in recent days are intensifying the usage of ICT among teachers to enhance the effectiveness of teaching and learning. Thus, the need on integrating Green ICT with the field of education is becoming more important than before1. At the global scenario, educational institutions have started creating awareness on sustainability issues using Green ICT approaches among young generation2

In spite of the attention given on the importance of ICT in schools, there is another aspect of ICT that has been left unattended which is the cultivation of knowledge in managing ICT infrastructures and the effects of mismanagement of ICT on humans and environment, or Green ICT. In Malaysian context, the implementation of Green ICT management initiatives have been initiated by KeTTHA in collaboration with the Policy and Planning Division3 As a result of this cooperation, ICT Guidelines towards Green ICT in the Public Service was introduced in 2010 for the implementation of management related to the acquisition, use and disposal of ICT equipment that support the National Green Technology Policy 4. Yet, though KeTTHA and MOE were both government agencies, initiatives of Green ICT by KeTTHA were not extended by MOE to be done in schools.

Importance of Teacher Awareness on Green ICT and Environmental Sustainability

Mismanagement of ICT have contributed 2% of global carbon distribution out of 28.9 billion ton carbon a year 5. Uncontrolled distribution of carbon could lead to the problem of Global Warming and unbalanced ecosystem 6. Such problem is caused by new ways in doing economic activities which resulted in extensive used of ICT7. Thus, the effort of cultivating the culture of ICT in schools should go side by side with the practice of Green ICT.

Green ICT focuses on efficiency in electricity usage and reducing the usage of harmful substances. In the context of a school, Green ICT is to be practiced by promoting efficient and effective usage of ICT elements either in the office, classroom, computer laboratories and other relevant places.

1.1. Knowledge, Attitude and Practice

Greenwald (1968) associated awareness to knowledge, attitudes and practices; in which in this study refers to knowledge, attitudes and practices of teachers on Green ICT in schools8. Legare et al. (2008) in his KAP Model discusses that awareness and norms are elements that leads to one's knowledge9.

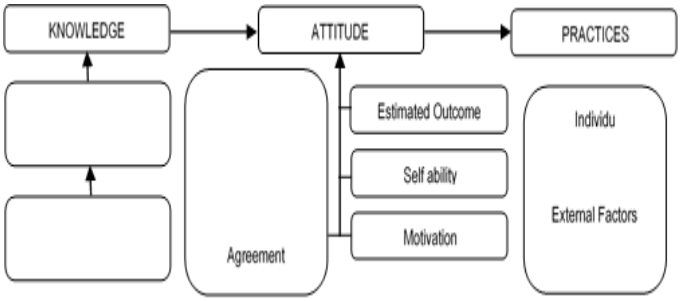


Figure. 1: An Example of Knowledge, Attitude and Practice Conceptual Model
Source: Legare et al. (2008)

Awareness are new knowledge formulated from previous knowledge10. Knowledge is the basis of an individual's attitude and practices11. Attitude, on the other hand is the level of inclination to react on certain situation; either positively or negatively 12 Changes of attitude happen when there is an increase of knowledge13 14. Practice is the final component in a KAP model. Practice is also related to enrichment and increase of knowledge15. Practice happens when an individual is aware of his knowledge has undergone the process internalizing his

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knowledge16. Thus, if a teacher is aware of the guidelines of using Green ICT, his attitude and practice might change positively.
In general, this study aimed to investigate the level of awareness among teachers of secondary schools on Green ICT. In specific, the main objectives of this study are to identify secondary school teachers' (from the category of digital natives and digital immigrants) knowledge, attitude and practice towards Green ICT.

2. Methodology and data analysis

This study adopted a quantitative research design. The study population is national type secondary school teachers from a chosen state in Malaysia. The total number of the study population is 5197 teachers. In general, teachers from national type secondary schools were frequently involved in environmental related programmes and activities organized by the State Education Department. The study population are also teachers who are regarded as generation Y teachers. Generation Y teachers as those who were born between the year of 1977-1997, living in the era of technology and development of ICT17. Based on Krejcie and Morgan (1970), table of sampling, the study identified 357 teachers as respondents of the study18. These respondents are teachers from 26 national type secondary schools. The sampling technique used in identifying these respondents is simple random sampling.
As for the research instrument, an adapted questionnaire was used. The questionnaire was adapted from an instrument meant to investigate respondents' knowledge, attitude and practice on renewable energy (RE) and Energy Efficiency (EE) by CETREE & GT (2004)19. The instrument was divided into a section on respondents' demography and four constructs with 56 items. The construct of the instruments are knowledge on ICT management, knowledge of Green ICT, attitude towards Green ICT and practice of Green ICT. The instrument has undergone a pilot study to ensure its reliability and the related value is reported in Table 1 and 2. The inferential analysis used were T-test, One-Way ANOVA and multiple regression. Normality test were also done.

Table 1: Kuder Richardson Formula of Research Instrument

Section	K-R_{20} value	Number of item
A: Knowledge on ICT Management	0.89	10
B: Knowledge on Green ICT	0.92	10
Total number of item		**20**

Table 2: Cronbach Alpha Value of Research Instrument

Section	α value	No of item
C: Attitude of Green ICT	0.81	12
D: Practice of Green ICT	0.88	24
Total number of item		**36**

3. Findings and discussion

3.1. Teachers' Knowledge on Green ICT

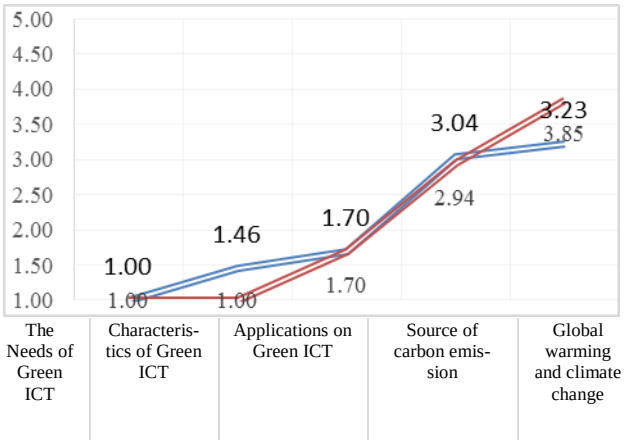
Since knowledge is an important component of a KAP model, insufficient knowledge on Green ICT could affect teachers' attitude and practices in handling issues related to ICT and environmental sustainability20 21. Nevertheless, findings from the quantitative data show an alarming result in which the mean value of teachers' knowledge on Green ICT is only 2.17, which is considered at a very low level (Table 2).

Table 3: Teachers' Knowledge on Green ICT

Topic	Mean score	Level
The Needs on Green ICT	1.00	Low
Characteristics of Green ICT	1.40	Low
Applications on Green ICT	1.70	Low
Sumber pengeluar gas karbon	3.00	Medium
Global warming and climate change	3.48	Medium
Overall Mean Score	**2.17**	**Low**

The aspect of dissemination of knowledge has been identified as a major factor that resulted in insufficient knowledge on Green ICT among teachers in educational institutions22. Other factors includes lack of fund and support from the higher authority, lack of awareness on the importance of Green ICT at the management level, lack of training and information given to the institutions on Green ICT such as its negative impact on the environment and lastly lack of attention given on the rules and regulation on Green ICT23.
The aspect of acceptance and awareness of ICT has been identified as the main factor that hinder the practices of Green ICT24. Yet, it is believed that positive acceptance towards technology and basic information on Green ICT is vital.25 Findings of the research further indicate that there is a knowledge gap between two generation of teachers; digital native teachers and digital immigrant teachers. Further analysis reveal that digital native teachers achieve higher mean score in the aspect of characteristics of Green ICT, but lower mean score in the aspect of global warming and climate change as compared to teachers from the digital immigrant generation.
Since characteristics of Green ICT is a new knowledge as prescribed by KeTTHA (2009), it could be understood that digital native generation (or new generation as named by Antonio et al. (2012), might have an advantage in understanding and processing new information related to technology26 27. However, the aspect of global warming and climate change, are more sensitively noted by digital immigrant teachers might be due to their life experience in dealing with nature and the environment. These findings is presented in Graph 1.

3.2. Mean Score



Graph 1: The achievement profile of teachers' knowledge on Green ICt (digital native and digital immigrant)

Table 4 is about teachers' knowledge on Green ICT based on generation and teaching experience. Findings also indicate that there is no difference on knowledge on Green ICT based on teachers' level of education. However, digital native teachers who possesses either First Degree or Diploma in Education have more knowledge on Green ICT as compared to teachers with similar qualification who are digital immigrants. Such findings coincide with Prensky (2001) suggestion that is the approach in seeking information is different between digital immigrant and digital native teachers28.
Digital immigrant teachers prefer to use printing sources to get information rather than online sources whereas digital native teachers choose online sources as their main reference. Findings also shows teachers' knowledge on Green ICT activities is limited to planting trees activities and electrical energy efficiency. Teachers have difficulties in relating technology with the concept of environmental sustainability, mainly in the aspect of energy effi-

ciency and negative impact of carbon distribution on the environment. Additionally, findings reveals that teachers are aware of environmental awareness mainly through courses and trainings offered by MOE and other agencies. However, environmental awareness highlighted in these courses does not covers a thorough concept of environmental sustainability. Instead, they are limited to pollution, environmental damage, and initiatives to improve the quality of nature through tree planting activities, water saving practices, waste management, recycling and reuse of resources with discretion29. In spite of numerous trainings and workshop provided for teachers, teachers merely grasp partial and narrow understanding on the concept of environmental sustainability.

Therefore, it could be said that teachers' exposure on the knowledge of Green ICT is very narrow due to lack of adequate information. Such limited exposure led to teachers' inability to grasp the relationship between the use of technology to Green ICT and the negative contributions of technology to the environment.

Table 4: Teachers' Knowledge on Green ICT by Generation and Teaching Experience

Year of birth	**Teaching experience**	**Mean (m)**	**Standard deviation (s.p)**	**Frequency (n)**
1980 and above (*digital native*)	< than 5 years	40.97	14.82	69
	6 to 10 years	40.41	16.41	96
	11 to 20 years	39.84	15.65	50
	More than 21 years	-	-	-
		40.46	15.67	215
1979 and below (*digital immigrant*)	< than 5 years	29.00	23.43	3
	6 to 10 years	25.67	9.54	6
	11 to 20 years	38.16	15.05	75
	More than 21 years	36.90	17.19	59
		36.92	16.04	143
Total	< than 5 years	40.47	15.22	72
	6 to 10 years	39.54	16.43	102
	11 to 20 years	38.83	15.26	125
	More than 21 years	36.90	17.19	59
		39.04	15.89	358

3.3. Teachers' Attitude on Green ICT in Schools

Research findings exposes that although the level of teachers' knowledge on Green ICT is low, teachers' attitude on Green ICT is at high level. Teachers have positive attitude towards the implementation of Green ICT in schools. Analysis shows that teachers' attitude towards Green ICT in schools is at high level with the mean score of 4.40. Table 6 indicates that there is no significant influence of knowledge on Green ICT (β = -0.76, t = -1.17, p = 0.24) on teachers' attitude towards Green ICT at the significant level of 0.05 (F (2,355) = 1.61; p = 0.20). Research finding also shows that ten out of twelve items in relation to teachers' attitude towards Green ICT reflected teachers' positive and high level of attitude towards Green ICT.

Those items are awareness on the electricity consumption in schools (mean score, 4.06), interest in practicing Green ICT (mean score, 4.27), opinion on authority's participation in educating teachers on Green ICT (mean score, 3.95), intention to practice Green ICT in schools (mean score, 4.03), the culture of Green ICT (mean score, 4.11), consciousness on the negative effect of ICT (mean score, 4.15), rules on implementation of ICT in schools (mean score, 3.93), adopting lifestyle that accommodates Green ICT (mean score, 3.96) and interest in discussing environmental issues (mean score, 3.91).

Table 5: Teachers' Knowledge on Green ICT by Generation and Level of Education

Year of birth	Education level	Mean (m)	Standard deviation (s.d)	Frequency (n)
1980 and above (digital native)	Teaching certificate	-	-	-
	Teaching diploma	39.00	14.31	6
	Bachelor degree	39.46	15.46	191
	Master degree	53.07	15.36	15
	Others	44.00	10.58	3
		40.46	15.67	215
1979 and above (digital immigrant)	Teaching certificate	38.00	-	1
	Teaching diploma	25.57	15.12	7
	Bachelor degree	37.58	16.59	115
	Master degree	34.27	12.25	15
	Others	45.40	7.96	5
		36.92	16.04	143
Total	Teaching certificate	38.00	-	1
	Teaching diploma	31.77	15.75	13
	Bachelor degree	38.75	15.89	306
	Master degree	43.67	16.66	30
	Others	44.88	8.29	8
		39.04	15.89	358

Such findings, which offer a non-linear relationship between knowledge, attitude or practices in relation to environmental sustainability are in agreement with findings presented by numerous researchers30 31 32 33. Therefore, high knowledge on environmental education does not ensure anyone to be adopting positive environmental practices34 35. This findings, however, is opposed to findings from some other researches 36 37 Findings also indicates that though teachers' possesses positive attitude towards Green ICT, but it is not at the expenses of their personal need and advantage. Kollmuss and Agyeman (2002) suggested that differences in priority might be one reason that leads to the non-linear relationship, for example; choosing between driving a car to fulfil certain need to awareness on gasses produce by the car38.

Table 6::Multiple Regression Analysis on Teachers Attitude and Teachers' Knowledge towards Green ICT in School

Variable	Beta standardised (β)	Statistic (t)	Significant (p)
Knowledge on Green ICT (Predictor)	-0.76	-1.17	0.24
Info: R = 0.10 R2 = 0.01 Adjusted R2 = 0.00 F Value = 1.61 p = 0.20			

Table 6 indicates that there is no significant influence of knowledge on Green ICT (β = -0.76, t = -1.17, p = 0.24) on teachers' attitude towards Green ICT at the significant level of 0.05 (F (2,355) = 1.61; p = 0.20).

3.4. Teachers' Practices of Green ICT in Schools

Findings also show that the mean score of teachers' practices of green ICT is at high level that is 3.67. Table 7 indicates that though there is no significant influence of knowledge on Green ICT (β = 0.12, t = 1.86, p = 0.06) on teachers' practices of Green ICT, there is some significant influence of teachers' attitude to-

wards Green ICT on teachers' level of 0.05(F (3,354) = 4.60; p = 0.00).

Table 7: Multiple Regression Analysis on Teacher' Knowledge, Attitude and Practices of Green ICT in Schools

Variable	Beta standardised (β)	Statistic (t)	Significant (p)
Knowledge on Green ICT(Predictor)	0.12	1.86	0.06
Attitude in Green ICT (Predictor)	0.17	3.23	0.00*
Info: *p < 0.05 R = 0.19 R2 = 0.04 Adjusted R2 = 0.03 F Value = 4.60 P = 0.00			

In spite of efforts made in propagating Green ICT, early studies found that the level of knowledge of Green ICT teachers was still low. This findings shows that high level of practice among teachers on Green ICT might not be due to their knowledge on Green ICT. Instead is mostly influenced by the socio-cultural background of the school which stress on energy savings. At the same time, effective usage of ICT resources was also been propagated which indirectly might give certain positive impact on the practice of Green ICT.

Based on the findings, the researcher believed that teachers are also not given thorough knowledge on issues related to environmental problems, including its causes and effects, the proper usage of technological equipment and devices and so forth. Yet, they were only exposed to methods in environmental care; through recommended activities. Thus, teachers' basic knowledge on environmental care is insufficient.

Without concrete foundation on knowledge related to environmental care, continuous and committed effort in practicing Green ICT is not possible 39. Besides, discussion and information given to teachers and students on environment are usually theoretical in nature; rather than practical40. The results of the study that shows knowledge did not influence the practice was in line with Fietkau and Kessel (1981) models used in the Kitzmuller (2013) study, but contrary to the model Kollmuss and Agyeman (2002)41 42 43. However, the study of Kitzmuller (2013) shows that knowledge is only acting as a modifier of pro-environmental action or practice through indirect effects44. Knowledge, in this scenario is an intermediary factor that affects ones appreciation towards the environment; which also leads to certain action or practice towards the environment either in a positive or negative way. In this case though knowledge does not give direct impact on the actions or practices of the environment, it is essential for moving actions45 46.

Other influences that can shape a person's attitude towards the environment is the normative influence47 48 49. Such normative influence could be referred as the school environment involving socio-cultural interaction among teachers. Therefore, the high frequency of teachers' practices in Green ICT is the result of school's own cultural environment50 51 52. In this regard, the influence of socio-cultural influence of a school could be traced back to Vygotsky theory (1929) 53. Bandura (1977) also has the same concept though Bandura places human interaction, environment and human habits as a major factor in the possibility of affecting teacher's practices54.

4. Conclusion

This research suggests that teachers' practices of Green ICT are not based on high school ICT knowledge management and high Green ICT knowledge. Instead, the practices is due to the existing school culture; without the teachers' knowledge of the importance of such practices. Yet, awareness on Green ICT in schools is paramount in order to ensure the environmental sustainability is advocated since school level.

Teachers will require to have both the subject matter content knowledge and also the appropriate planning and method for knowledge dissemination strategies of Green ICT in schools. Thus, this paper calls for new input in existing guidelines so that the knowledge of green ICT for teacher in schools could be enhanced.

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