


# Green Computing Practice in ICT-Based Methods: Innovation in Web-Based Learning and Teaching Technologies

Suplab Kanti Podder, Dayananda Sagar College of Arts, Science, and Commerce, India

Debabrata Samanta, CHRIST University (Deemed), India

 <https://orcid.org/0000-0003-4118-2480>

## ABSTRACT

Green computing is the system of implementing virtual computing technology that ensures minimum energy consumption and reduces environmental waste while using computer. ICT-based teaching and learning (ICT-BTL) tools can be implemented for effective and quality education especially during the pandemic like COVID-19. The researchers collect the data from original sources with their personal experiences and eagerness to understand the concept in depth and the applicability for prospective mankind. The results include positive impacts of developing and implementing the green computing for ICT-BTL tools in smart classrooms. ICT experts and entrepreneurs believe in initiating the virtual classroom operations for the betterment of future and protecting from the faster growing technology era in education and research industry. The present study can be initiated for developing modern classrooms and ICT-based education system with 3D presentation, demonstration of practical examples in the realistic manner.

## KEYWORDS

3D Presentation, Computer Application, E-Waste, Green Computing, ICT, ICT-BTL

## 1. GREEN COMPUTING INSPIRATIONS FOR ICT-BTL

Green computing concept originated during the year 1992 while most of the companies initiated energy star for the electronic goods like printer, television, refrigerators, air conditioner, etc. which was the indication of energy efficiency (Asikainen et al. 2019), (Billett, Paulina and Martin, Dona, 2018). Millions of computers are used by individuals and organizations that consume the maximum portion of energy (Chatterjee, S., Bhattacharjee, K.K, 2020). With the consideration of proper utilization of renewable and non-renewable energy, different research institutions under government and non-government initiated to find the solution of reducing environmental waste and ensure energy efficiency that leads to discover the idea of green computing (Boud, D, et al. 1993), (Boyle, et al. 2019). ICT-BTL system has interconnections with green computing that leads a society into eco-friendly movement and sustainable development. UNESCO describes the importance of energy savings and released the guidelines for using the ICT-BTL practices exclusively in the developing countries. ICT-BTL system aggressively initiated by various countries like Chile, Costa Rica, Jordan, Macedonia, Malaysia, Russia, Namibia, Singapore, South Korea, and Uruguay. The system brings

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those countries into new heights of education, research and development and applications (Debabrata Samanta, S K Podder. 2019).

In the modern era, most of the institutions are developing and implementing virtual classroom using information and communication technology that demanded more number of computers (Edo, et al. 2019) (Arpaci, I., Basol, G, 2020). If the usage of all computers deliberates the green computing system, then the level of energy consumption reduces. So, the topic of the present research study relevant to Impact of Green Computing practices on ICT-BTL Tools.

## 1.1 Green Computing Practices

Green computing practices can be summarized with the consideration of the situation, purpose, or changing scenario of social and organizational requirements during pandemic like Covid 19. The most common green computing practices are addressed as follows:

*Buy Energy Efficient Hardware:* Purchase and usage of energy efficiency hardware are the first category of initiating green computing practices on ICT-BTL Tools (Jarrett, Kendall and Ellis, Laura, 2020). The decision-makers should take smart initiatives for selecting energy efficient hardware that consumes less energy with maximum efficiency (Myunghee k., et al. 2011), (Nilanjana D., et al. 2016).

*Using the Solar Power System:* Solar power is the emblem of the biggest green initiative. Solar power system deployment is less onerous and can be used for a long time. The usage of the solar power system is eco-friendly and not having any harmful effects for the users as well as society.

*Recycle Systems and Supplies:* ICT-BTL claim a large number of instruments. The strategies of purchasing and utilizing those instruments should be productive concerning recycling and reuse.

*Reduce Paper Consumption:* The traditional teaching and learning methods were depending on paperwork. Consumption of large quality of paper destroys the trees which have a direct impact on the environment. ICT-BTL tools can ensure the less consumption of paper and alternatively more use of energy-efficient modern instruments (David Luyombya, 2011).

*Use Virtualization Technology:* Virtual technology is another Green Computing Practice which has no physical existence in any specific geographic location. The service provider has the technology by providing the required service from the virtual platform without physical contact.

*Encourage Telecommuting:* In the modern technological era, most of the advanced organizations are performing smart operations through telecommuting. We are moving towards the same direction in which the modern teaching and learning system will be encouraged by telecommuting for all kinds of inquiries and services (Butt, Adam, 2018).

*Activity-Based Teaching and Learning:* We all are witnesses of conducting various activities in the classroom with the presence of teachers and students. Similarly, ICT-BTL systems can be engaged in the teachers and students to perform various activities in the virtual platform (Suplab Kanti Podder, Debabrata Samanta, 2020).

*Digital Evaluation and Certification:* Effective education system ensures systematic knowledge and recognition with certification. ICT-BTL not only guarantees the improvement of knowledge, but also issues the authenticated certificate which is recognized by all national and international organizations.

## 1.2 ICT-BTL Tools

*Digital Content:* Digital contents are the study materials that are published in digital format. This is an important ICT-BTL tool for communicating and preparing through the digital mood of the education system (Cooney, et al. 2018), (Damian O., et al. 2015). Digital content includes maintaining the soft copy of teaching materials in the folders of relative computers, sources of the respective e-books, e-workbooks, web links, e-tests, etc.

*Technology and Network Infrastructure:* Updated technology and relevant network infrastructure are another necessary tool for the ICT - BTL system. For better performance of the teaching and learning system, both the institution and learners should have upgraded network infrastructure facilities.

*Training and Development Tools:* Effective ICT-BTL systems depend on the efficient performance of teachers. All the teachers should be trained through an orientation program and Faculty Development Program before starting the session. At the same time, the learners should be trained in becoming familiar with the optimum use of technology and network system (S K Podder, 2019), (Samuel O. A., 2006).

*Institutional Support:* ICT-BTL system is the digital mode of conducting classes for the large categories of the population. The institutional supports are essential to make an impressive success for the teaching fraternity, learners, institutions, and society at large (Njoku, Anuli, 2019), (Paolo N., Danilo P., 2018).

### 1.3 Review of Literature

The research topic imitated by the researchers and their curiosity towards the green computing, especially for energy efficiency and virtual classroom activities. Various research papers were reviewed related to green computing, ICT, virtual classroom, energy efficiency and e-waste that guided the sources of idea and further research creativity.

Table 1 in the literature review section showing all the merits/demerits of discussing the relevant work for a quick understanding at a glance.

However the existing research study and the outcomes provided idea, indications related to green computing and ICT in the classroom, but did not reveal the complete guidelines and solutions of several issues that create the research gap. The researchers identified various objectives and commended for original research work to reduce the identified research gap.

### 1.4 Objectives of the Research

Various objectives were identified with the consideration of the research gap and curiosity of the researchers:

- To find out various Green Computing Practices for ICT-BTL system.
- To identify the Impact of Green Computing practices on ICT-BTL Tool like Digital Content.
- To find out the Impact of Green Computing practices on ICT-BTL Tool like Technology and Network Infrastructure.
- To identify the Impact of Green Computing practices on ICT-BTL Tool like Training and Development.
- To find out the Impact of Green Computing practices on ICT-BTL Tool like Institutional Support.

### 1.5 Hypotheses for the Research Study

$H_{01}$ : All the Green Computing practices together do not have positive impact on Digital Content.

Mathematically,  $H_{01}$ : [Impact of Green Computing practices on ICT-BTL Tool like Digital Content] = 0.

$H_{02}$ : All the Green Computing practices together do not have positive impact on Technology and Network Infrastructure.

Mathematically,  $H_{02}$ : [Impact of Green Computing practices on ICT-BTL Tool like Technology and Network Infrastructure] = 0.

Table 1. shows the comparison of review of literatures with merits and demerits

Sl. No.	Concept of the Research	Merits	Demerits
1	Green computing practices responses the sustainable IT services for better management operations. Energy efficient technology develops the system of sustainable society. (Olson, G., 2008). Using computer science and communication technology leads to efficient performance and improved productivity (Pattanaphanchai, Jarutas, 2019). Implementation of green concept in the modern society helps for energy efficiency and environmental friendly activities which is not harmful for the society (Paterson, et al. 2020).	The research study indicates the significance of implementing green computing in the personal, social and organizational practices. Various resources of the organizations can be utilized properly with the consideration of economic cost that may leads to competitive advantages.	The outcomes of the present study are not realistic because of the high installation charges of green computing system, most of the organization will not implement in the regular practices. The initial investment is high that force the organizations to find the alternatives. The continuous changes of technology are other demerits of implementing green computing initiatives.
2	Green computing can be initiated by using of solar power system which is generated by direct sunlight which is completely pollution free and the best solution of power generation (S K Podder, Debabrata Samanta 2019). Green computing initiatives reflect the positive impact on ICT based teaching and learning methods that improve the quality of education and the implications (Adie, L., 2013).	The research study revealed the systematic guidelines for developing the infrastructure in such way that can ensure the efficiency level of energy generation and consumption.	The authors of the articles limited the data collection in the restricted areas to collect data and resolve the limited issues that can be the representative for the target population.
3	ICT based teaching and learning method is the combination of utilizing communication technology and expert insights to develop sustainable education system. The system can be beneficial for the next generation educators in the rural and underdeveloped areas (Ghavifekr, Simin; Rosdy, Wan Athirah Wan., 2015).	The research study revealed the positive impact of 3d presentation that can be used for better and effective presentation and interactive classroom session.	The research outcomes may not be suitable for all categories of family background. The students cannot get the opportunities for innovative practices in smart classroom because of the financial issues.
4	Wind turbine is the source of generating power and be used for executing computers in virtual classroom activities through ICT. Generating power through wind turbine reduces carbon dioxide emission that leads to sustainable development (Turugare, M., Rudhumbu, N, 2020). ICT based teaching and learning system has interconnection with green computing that leads a society into eco-friendly movement and sustainable development. With the consideration of proper utilization of renewable and non-renewable energy, different research institutions under government and non-government initiated to find the solution of reducing environmental waste and ensure energy efficiency that leads to discover the idea of green computing (Boyle, et al.2019).	The research study describes the importance of using wind turbine that facilitates eco-friendly power generation. The study helps to utilize of renewable and non-renewable energy, different research institutions under government and non-government initiated to find the solution of reducing environmental waste and ensure energy efficiency.	The research studies describe about the limitation of job security under ICT based teaching and learning education system. Lack of training and development system increases the gap between the knowledge and modern institutional expectations that creates more unemployment problems in rural and backward areas.
5	E-waste is the challenge for the computerized education system that needs to be addressed and necessary to take initiatives of reducing. The fastest-growing pollution problems can be reduced through green computing system (Peeranart Kiddee, Ravi Naidu, and Ming H. Wong., 2013). In the modern era, most of the institutions are developing and implementing virtual classroom using information and communication technology that demanded more number of computers (Edo, et al. 2019) (Arpaci, I., Basol, G, 2020).	The present study is suitable for the development of sustainable society by reducing e-waste. The research initiatives also creates public awareness regarding the usage of modern equipment's which are eco-friendly and recyclable.	The research study and the outcomes are not fruitful until the implementations happening in the ground level. The expensive equipment and high installation charges restrict the general public and small scale enterprises to implement.

$H_{03}$ : All the Green Computing practices together do not have positive impact on Training and Development.

Mathematically,  $H_{03}$ : [Impact of Green Computing practices on ICT-BTL Tool like Training and Development] = 0.

$H_{04}$ : All the Green Computing practices together do not have positive impact on Institutional Support.

Mathematically,  $H_{04}$ : [Impact of Green Computing practices on ICT-BTL Tool like Institutional Support] = 0.

## 2. EXPERIMENTAL METHODS

The research study initiated for identifying the green computing practices, ICT-BTL tools and finally to understand the relationship between these two factors. Researcher initiated for collecting the data from original sources and trusted agencies that ensured the reflection of the main purposes of the research study.

### *Research Design*

The research questions and consequently the research objectives call for a hybrid research design which is a combination of exploratory, descriptive and causal approaches carried-out without manipulation of the prevailing conditions in the form of empirical research.

### *Instruments of the Research Study*

Various instruments, i.e., Delphi Technique, Questionnaire Design and Factor Analysis were employed. At first all the relevant three categories of factors were identified through Delphi Techniques, Questionnaire was designed based on the variables related to those factors and the factors were confirmed by Factor Analysis.

### *Utilize of Delphi Technique*

At first, Delphi technique has executed to identify the green computing practices (independent variables) and ICT-BTL tools (dependent variables).

At first, 10 experts were selected from diverse background and built Delphi Panel. The experts were asked about their opinion regarding outsourcing experience related to their organization. In the first attempt the experts were unseen about the main concept and they have given some opinions, the researcher has taken it consideration the commonality of the opinions.

At the second attempt, the same experts were asked for their opinions those who have given their opinions previously. In this attempt the experts have identified some common patterns that were further refined with the consideration of previous commonality. Like this, the process is done repeated three times to arrive at the desired factors.

### *Pilot Study*

Researchers prepared the statements based on the variables that led to prepare a questionnaire. Pilot test has initiated on 80 samples to verify the quality, consistency and relevance of questions with respect to the title and objectives of the research study.

### *Normality tests (K-S Test) and Randomness*

Test Before initiating the data analysis, the normality tests (K-S Test) and Randomness Test (Run Test) were executed and observed the collected data as normality in nature.

### *Define the Research Variables*

There are two variables such as causal factors are the independent variables and effect factors are the dependent variables.

### *Sample Size and Data Collection*

The final questionnaires were distributed among the sample audiences (Decision-makers, students, parents, experts in education industry, and teachers). Electronic mode of distribution and collection of data was executed among respondents belongs to various cities like Bangalore, Mumbai, Ahmedabad, Patna, Kolkata, Chennai and Hyderabad in India.

Total 575 questionnaires were sent and approached to respond the same, but 425 questionnaires were received out of that 25 questionnaires were rejected because of the incomplete data. The collected data were identified as the combination of descriptive and inferential statistics. The descriptive statistics are presented as the frequency distribution chart and inferential statistics are demonstrated on analysis part.

### *Justification for Selecting Research Area*

After identifying the variables, the questionnaire has designed to collect required data from the reliable and responsive representative of entire population. Sample design is a means of structuring the sample to select a subset of units from a target population for the purpose of collecting required information. This information is used to draw inferences about the population as a whole. The respondents were ensured by conducting the survey among decision-makers, students, parents, experts in education industry, and teachers in reputed institutions in India. The geographical locations were selected from various cities like Bangalore, Mumbai, Ahmedabad, Patna, Kolkata, Chennai and Hyderabad to ensure the actual representatives of the population. The up gradation of education systems are implemented in metro or capital cities followed by the rest of the cities and villages time to time. Being an individual researcher I have my own constrain, therefore I have restricted to the limited categories of respondents and geographical locations.

## **3. ANALYSIS WITH DISCUSSION**

The analysis consists of a systematic arrangement of collecting data, tabulation, codification, and analysis by using of relevant statistical tools. The present study includes two statistical methods like frequency distribution and Multiple Regression Analysis.

### **3.1 The Results With Respect to Green Computing Practices**

With the consideration of expert opinion and impressions from various respondents regarding green computing practices were identified. All the respondents were asked the opinion and observation regarding importance of implementing various computer instruments for ICT-BTL system (Table 2).

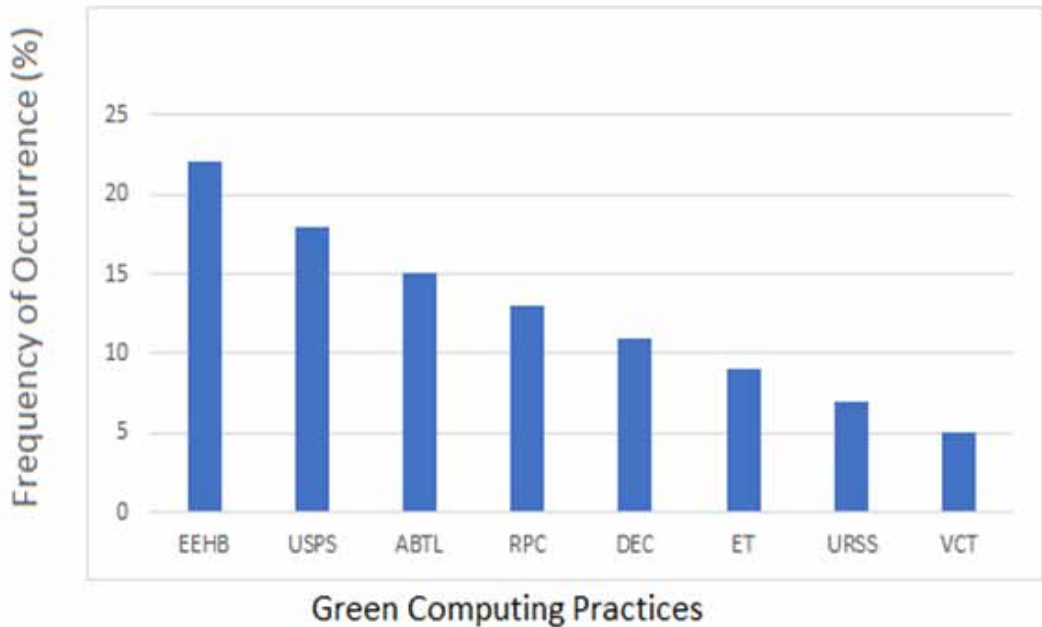
Most of the respondents skewed their priority to buy energy efficient hardware for green computing practices comparable to other initiatives like use solar power system, activity-based teaching and learning, reduce paper consumption etc.

While considering green computing practices (Figure 1), maximum experts and respondents indicated the name of buy energy efficient hardware followed by use solar power system, activity based teaching and learning, reduce paper consumption, digital evaluation and certification, encourage telecommuting, recycle systems and supplies, virtual communication technology. The respondents' opinion summarized that the education institutions should take maximum precautions before planning and selecting computer hardware for ICT-BTL system. If the performance of the installation tools shows eco-friendly, ICT-BTL system becomes more efficient in the sense of operations and sustainability.

Table 2. show the green computing practices on ICT-BTL tools

Sl. No.	Green Computing Practices	Frequency of Occurrence (%)
1	Energy Efficient for Hardware Buying (EEHB)	22
2	Use Solar Power System (USPS)	18
3	Activity Based Teaching and Learning (ABTL)	15
4	Reduction of Paper Consumption (RPC)	13
5	Digital Evaluation and Certification (DEC)	11
6	Encourage Telecommuting (ET)	9
7	Use of Recycle Systems and Supplies (URSS)	7
8	Virtual Communication Technology (VCT)	5
<b>Total</b>		<b>100</b>

Figure 1. show the green computing practices on ICT-BTL tools that are taken into consideration by individuals and experts



### 3.2 The Results with Respect To ICT-BTL Tools

With the consideration of expert opinion and sample audience respondents Table 3 was prepared and showed the ICT-BTL tools and frequency of occurrence (%).

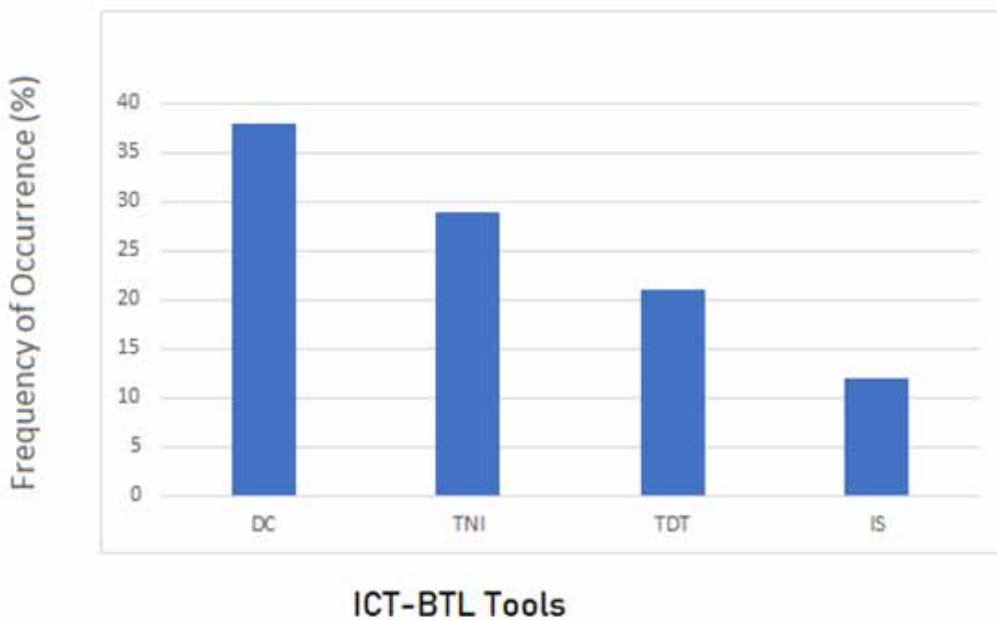
Digital content is the most important tools for ICT-BTL system with the consideration of audience responses. The digital content skewed the priority over other related tools like technology and network infrastructure, training and development tools, and institutional support. The respondents feel there is connectivity among the above mentioned tools and leads by the digital content preparation, storing and implementation of efficient ICT-BTL system.

Table 3. show the results with respect to ICT-BTL tools

Sl. No.	ICT-BTL Tools	Frequency of Occurrence (%)
1	Digital Content (DC)	38
2	Technology and Network Infrastructure (TNI)	29
3	Training and Development Tools (TDT)	21
4	Institutional Support (IS)	12
<b>Total</b>		<b>100</b>

Figure 2 interprets the importance and priority of using ICT-BTL tools and their implementation for quality education system. Preparing and maintaining of digital contents which are required for teaching, assessment and evaluation follows by technology and network infrastructure, training and development tools, and institutional support.

Figure 2. highlight the results with respect to ICT-BTL tools



The priority based responses were considered and observed critically in the further analysis on multiple regression analysis. Finally the summary of findings and conclusions were addressed the same considerations.

### 3.3 The Results of Multiple Regression Analysis (MRA) Between Dependent Variable (Digital Content) and Eight Independent Variables

Multiple Regression Analysis (MRA) was employed and shown in the Table 4. The results of MRA between dependent variable (Digital Content) and eight independent variables (Buy Energy Efficient



Table 4. The result of MRA elated to digital content tool and eight green computing practices.

<b>Highlights of Multiple Regression Analysis (MRA)</b>						
Dependent Variable: Digital Content, N: 400, Multiple R (MR): 0.759, Squared multiple R (SMR): 0.576, Adjusted squared multiple R (ASMR): 0.571, Standard error of estimate (SEE): 0.658						
<b>Summary of Multiple Regression Analysis</b>						
Effect	Coeff	Std Error	StdCoeff	Tolerance	t	Sig.
The Constant	8.175	0.431	0.000	-	18.984	0.000
Buy Energy Efficient Hardware	-0.355	0.072	-0.236	0.992	-4.946	0.000
Use Solar Power System	-0.860	0.124	-0.286	0.636	-6.957	0.000
Recycle Systems and Supplies	0.278	0.038	0.282	0.724	7.323	0.000
Reduce Paper Consumption	-0.145	0.036	-0.193	0.892	-4.036	0.015
Virtual Communication Technology	0.103	0.044	0.106	0.493	2.287	0.023
Encourage Telecommuting	-0.274	0.026	-0.363	0.882	-10.410	0.000
Activity Based Teaching and Learning	-0.445	0.039	-0.428	0.759	11.357	0.000
Digital Evaluation and Certification	0.561	0.039	0.518	0.828	14.383	0.000
<b>Significant at 0.05 level</b>						
<b>ANOVA</b>						
Source	Sum-of-Squares	df	Mean-Square	F-ratio	Sig.	
<b>Regression</b>	231.912	5	46.382	107.215	0.000	
<b>Residual</b>	170.448	394	0.433			
<b>Significant at 0.05 level</b>						
<b>Test for Existence of Correlation Amongst the Error Terms</b>						
Durbin-Watson D Statistic = 2.233; First Order Autocorrelation = 0.198 Not significant at 0.05 level, where the null hypothesis (Ho) involved was “there is no correlation amongst the residual (error) terms in the regression model”. The null hypothesis was not rejected. Thus, absence of correlation and error terms cancelling each other is proved.						

Hardware, Use Solar Power System, Recycle Systems and Supplies, Reduce Paper Consumption, Virtual Communication Technology, Encourage Telecommuting, Activity Based Teaching and Learning, and Digital Evaluation and Certification).

Table 4 reveals the multiple regression analysis and the summary of t-test, and ANOVA test with respect to 5% significance. The t-test result indicates the impact of individual independent variable on dependent variable “digital content”. On the other side the ANOVA test result indicates the impact of all eight independent variables together on dependent variable “digital content”.

The F statistic is a test of significance for the entire regression. At 5% significance, this regression is statistically significant because p-value<0.05.

At 5% significance, t-values of all the eight independent variables are statistically significant because their corresponding p values <0.05. Therefore, all the eight independent variables are independently useful in the prediction of digital content.

### 3.4 The Results of MRA Between Dependent Variable (Technology and Network Infrastructure) and Eight Independent Variables

MRA was employed and the results are shown in the Table 5. This result of MRA between dependent variable (Technology and Network Infrastructure) and eight independent variables (Buy Energy Efficient Hardware, Use Solar Power System, Recycle Systems and Supplies, Reduce Paper Consumption, Virtual Communication Technology, Encourage Telecommuting, Activity Based Teaching and Learning, and Digital Evaluation and Certification).

Table 5 elucidates the multiple regression analysis and the summary of t-test, and ANOVA test with respect to 5% significance. The t-test indicates the impact of individual independent variable on dependent variable “Technology and Network Infrastructure”. On the other side the ANOVA test result indicates the impact of all eight independent variables together on dependent variable “Technology and Network Infrastructure”.

Table 5. obtained the results of MRA related to Technology and Network Infrastructure and Green Computing practices

<b>Highlights of Multiple Regression Analysis</b>						
Dependent Variable: Technology and Network Infrastructure, N: 400, MR: 0.438, SMR: 0.192, ASMR: 0.180, SEE: 0.903						
<b>Summary of Multiple Regression Analysis</b>						
<b>Effect</b>	<b>Coeff</b>	<b>Std Error</b>	<b>StdCoeff</b>	<b>Tolerance</b>	<b>t</b>	<b>Sig.</b>
The Constant	6.890	0.681	0.000	-	10.121	0.000
Buy Energy Efficient Hardware	0.456	0.125	0.478	0.376	7.310	0.000
Use Solar Power System	-0.462	0.175	-0.155	0.597	-2.638	0.009
Recycle Systems and Supplies	0.142	0.065	0.145	0.462	2.173	0.030
Reduce Paper Consumption	0.007	0.046	0.009	0.546	0.145	0.885
Virtual Communication Technology	0.424	0.129	0.546	0.371	7.121	0.000
Encourage Telecommuting	-0.145	0.037	-0.194	0.856	-3.958	0.000
Activity Based Teaching and Learning	-0.262	0.055	-0.253	0.733	-4.787	0.000
Digital Evaluation and Certification	0.356	0.054	0.331	0.828	6.646	0.000
<b>**Significant at 0.05 level</b>						
<b>ANOVA</b>						
<b>Source</b>	<b>Sum-of-Squares</b>	<b>df</b>	<b>Mean-Square</b>	<b>F-ratio</b>	<b>Sig.</b>	
<b>Regression</b>	76.238	5	12.706	15.897**	0.000	
<b>Residual</b>	320.402	394	0.815			
<b>**Significant at 0.05 level</b>						
<b>Test for Existence of Correlation Amongst the Error Terms</b>						
Durbin-Watson D Statistic = 1.294***; First Order Autocorrelation = 0.192 ***Not significant at 0.05 level, where the null hypothesis (Ho) involved was “there is no correlation amongst the residual (error) terms in the regression model”. The null hypothesis was not rejected. Thus, absence of correlation and error terms cancelling each other is proved.						

The F statistic is a test of significance for the entire regression. At 5% significance, this regression is statistically significant because  $p\text{-value} < 0.05$ .

At 5% significance, t-values of all the eight independent variables are statistically significant because their corresponding p values  $< 0.05$  except “reduce paper consumption” because few respondents believe that efficient teaching leaning completely cannot replace the paper work. Therefore, all the seven independent variables are independently useful in the prediction of digital content.

### **3.5 The Results of MRA Between Dependent Variable (Training and Development) and Eight Independent Variables**

MRA was employed and the results are shown in the Table 6. This result of MRA between dependent variable (Training and Development) and eight independent variables (Buy Energy Efficient Hardware, Use Solar Power System, Recycle Systems and Supplies, Reduce Paper Consumption, Virtual Communication Technology, Encourage Telecommuting, Activity Based Teaching and Learning, and Digital Evaluation and Certification).

Table 6 reveals the multiple regression analysis and the summary of t-test, and ANOVA test with respect to 5% significance. The t-test result indicates the impact of individual independent variable on dependent variable “Training and Development”. On the other side the ANOVA test result indicates the impact of all eight independent variables together on dependent variable “Training and Development”.

The F statistic is a test of significance for the entire regression. At 5% significance, this regression is statistically significant because p value  $< 0.05$ .

At 5% significance, t-values of all the eight independent variables are statistically significant because their corresponding p values  $< 0.05$ . Therefore, all the eight independent variables are independently useful in the prediction of digital content.

### **3.6 Analysis of MRA Between Dependent Variable (Training and Development) and Eight Independent Variables**

MRA was employed and the results are shown in the Table 7. This result of MRA between dependent variable (Institutional Support) and eight independent variables (Buy Energy Efficient Hardware, Use Solar Power System, Recycle Systems and Supplies, Reduce Paper Consumption, Virtual Communication Technology, Encourage Telecommuting, Activity Based Teaching and Learning, and Digital Evaluation and Certification).

Table 7 reveals the multiple regression analysis and the summary of t-test, and ANOVA test with respect to 5% significance. This t-test result indicates the impact of individual independent variable on dependent variable “Institutional Support”. On the other side the ANOVA test result indicates the impact of all eight independent variables together on dependent variable “Institutional Support”.

The F statistic is a test of significance for the entire regression. At 5% significance, this regression is statistically significant because p value  $< 0.05$ .

At 5% significance, t-values of all the eight independent variables are statistically significant because their corresponding p values  $< 0.05$ . Therefore, all the eight independent variables are independently useful in the prediction of digital content.

## **4. FINDINGS AND SUGGESTIONS**

### **4.1 Summary of Findings**

While considering green computing practices, maximum experts and respondents indicated the name of buy energy efficient hardware followed by use solar power system, activity based teaching and learning, reduce paper consumption, digital evaluation and certification, encourage telecommuting, recycle systems and supplies, virtual communication technology. The respondents’ opinion summarized that

Table 6. Acknowledged MRA related to Training and Development and Green Computing practices

<b>Highlights of Multiple Regression Analysis</b>						
Dependent Variable: Training and Development, N: 400, MR: 0.628, SMR: 0.394, ASMR: 0.386, SEE: 1.237						
<b>Summary of Multiple Regression Analysis</b>						
<b>Effect</b>	<b>Coeff</b>	<b>Std Error</b>	<b>StdCoeff</b>	<b>Tolerance</b>	<b>t</b>	<b>Sig.</b>
The Constant	2.436	0.740	0.000	-	2.781	0.000
Buy Energy Efficient Hardware	0.250	0.090	0.228	0.271	2.768	0.000
Use Solar Power System	0.324	0.102	0.210	0.201	3.194	0.000
Recycle Systems and Supplies	0.436	0.075	0.477	0.275	5.824	0.000
Reduce Paper Consumption	-0.208	0.068	-0.235	0.314	-3.066	0.000
Virtual Communication Technology	-0.164	0.061	-0.226	0.263	-2.697	0.002
Encourage Telecommuting	-0.252	0.079	-0.198	0.482	-3.199	0.000
Activity Based Teaching and Learning	0.713	0.237	0.531	0.356	6.589	0.000
Digital Evaluation and Certification	0.346	0.112	0.136	0.218	0.268	0.000
<b>**Significant at 0.05 level</b>						
<b>ANOVA</b>						
<b>Source</b>	<b>Sum-of-Squares</b>	<b>df</b>	<b>Mean-Square</b>	<b>F-ratio</b>	<b>Sig.</b>	
<b>Regression</b>	263.477	5	32.935	18.923**	0.000	
<b>Residual</b>	680.521	394	1.740			
<b>**Significant at 0.05 level</b>						
<b>Test for Existence of Correlation Amongst the Error Terms</b>						
Durbin-Watson D Statistic = 2.487***; First Order Autocorrelation = 0.197 ***Not significant at 0.05 level, where the null hypothesis (Ho) involved was "there is no correlation amongst the residual (error) terms in the regression model". The null hypothesis was not rejected. Thus, absence of correlation and error terms cancelling each other is proved.						

the educational institutions should take maximum precautions before planning and selecting computer hardware for ICT-BTL system (Woyo, E., Rukanda, G.D. & Nyamapanda, Z, 2020).

Preparing and maintaining of digital contents which are required for teaching, assessment and evaluation follows by technology and network infrastructure, training and development tools, and institutional support(Perryman A, Seal T 2016), (Rafe V, Hosseinpouri R 2015). The priority based responses were considered and observed critically in the further analysis on multiple regression analysis. Finally the summary of findings and conclusions were addressed the same considerations (Savage, Julia and Healy, Jillian, 2019).

There is a positive impact green computing practices on ICT-BTL tools which are used for performing effective classroom activities. At 5% level of significance, t-values of all the eight independent variables are statistically significant because their corresponding p values <0.05. Therefore, all the eight independent variables are independently useful in the prediction of digital content(Sheridan, et al. 2019), (Smith, C 2012).

Table 7. Revealed the outputs of MRA related to Institutional Support and Green Computing practices

Highlights of Multiple Regression Analysis						
Dependent Variable: Institutional Support, N: 400, MR: 0.773, SMR: 0.597, ASMR: 0.589, SEE: 0.956						
Summary of Multiple Regression Analysis						
Effect	Coeff	Std Error	StdCoeff	Tolerance	t	Sig.
<b>The Constant</b>	-2.174	0.739	0.000	-	-2.361	0.000
Buy Energy Efficient Hardware	0.438	0.090	0.370	0.271	4.854	0.000
Use Solar Power System	0.351	0.102	0.304	0.201	3.441	0.000
Recycle Systems and Supplies	0.334	0.183	0.230	0.404	3.810	0.000
Reduce Paper Consumption	-0.025	0.068	-0.026	0.314	-0.367	0.016
Virtual Communication Technology	-0.423	0.061	-0.256	0.263	-3.021	0.000
Encourage Telecommuting	-0.205	0.079	-0.148	0.482	-2.598	0.000
Activity Based Teaching and Learning	0.536	0.234	0.478	0.247	6.012	0.000
Digital Evaluation and Certification	0.256	0.109	0.167	0.261	1.024	0.000
<b>**Significant at 0.05 level</b>						
ANOVA						
Source	Sum-of-Squares	df	Mean-Square	F-ratio	Sig.	
<b>Regression</b>	464.712	5	56.089	32.585**	0.000	
<b>Residual</b>	628.685	394	1.736			
<b>**Significant at 0.05 level</b>						
Test for Existence of Correlation Amongst the Error Terms						
Durbin-Watson D Statistic = 2.387***; First Order Autocorrelation = 0.196 ***Not significant at 0.05 level, where the null hypothesis (Ho) involved was “there is no correlation amongst the residual (error) terms in the regression model”. The null hypothesis was not rejected. Thus, absence of correlation and error terms cancelling each other is proved.						

The t-test result indicates the impact of individual independent variable on dependent variable “Technology and Network Infrastructure”. The ANOVA test result indicates the impact of all eight independent variables together on dependent variable “Technology and Network Infrastructure”. At 5% level of significance, t-values of all the eight independent variables are statistically significant because their corresponding p values < 0.05 except “reduce paper consumption” because few respondents believe that efficient teaching learning completely cannot replace the paper work. Therefore, all the seven independent variables are independently useful in the prediction of digital content.

The t-test result focuses impact of individual independent variable on dependent variable “Training and Development”. On the other side the ANOVA test result indicates the impact of all eight independent variables together on dependent variable “Training and Development”. At 5% level of significance, t-values of all the eight independent variables are statistically significant because their corresponding p values < 0.05. Therefore, all the eight independent variables are independently useful in the prediction of digital content.

The summary of t-test indicates the impact of individual independent variable on dependent variable “Institutional Support”. On the other side the ANOVA test result indicates the impact of all

eight independent variables together on dependent variable “Institutional Support”. At 5% level of significance, t-values of all the eight independent variables are statistically significant because their corresponding p values <0.05. Therefore, all the eight independent variables are independently useful in the prediction of digital content.

The summary of the results reveal the responds which are satisfactory to the green computing initiatives for developing and implementing the ICT in classroom activities. On the other side, the ICT experts and entrepreneurs initiating the virtual classroom operations give positive opinion regarding the green computing initiatives (Sonnenschein, et al. 2020). They feel, there are enormous opportunities for developing and implementing ICT in classroom with the green computing initiative which is environmentally friendly and reduces e-waste.

The HRD Ministry, Government of India has taken various productive initiatives and updated the education policy and system through NMEICT, SWAYAM, MOOCs, SWAYAM Prabha, National Digital Library (NDL), Spoken Tutorial, Free and Open Source Software for Education (FOSSEE), Virtual Lab, and e-Yantra. The present research findings are interrelated to those education systems to encourage the teachers and students for digital education system.

## 4.2 Suggestions

### 4.2.1. *The Important Suggestions to the Related Education Institutions Which can be Implemented in the Broader Area*

- Preparing effective Higher Education is the collective and collaborative work of top level managerial personnel, regular employees and other stakeholders.
- With the consideration of the reputation of the organization, all the stakeholders should take initiative of implementing the Information and Communication Technology to maintain effective Higher Education with respect to sustainable development. Adequate funding is an important aspect for fulfilling the ICT requirements.
- The management should take responsibility of ensuring the required ICT Infrastructure, Digital Television, Artificial intelligence, and Robotics Support that guarantee the quality Higher Education system. The decision-makers should play major role with respect to the challenges faced by professionals when interacting with the roles of ICT.
- The faculties should get systematic training for implementing green computing practices that finally leads to eco-friendly initiative and sustainable development.
- The Ministry of Human Resources Development should prepare the guidelines of performing ICT based education system and in the same time announcing rewards for using green computing practices that encourages the institutions and policy makers.

## 5. PRACTICAL IMPLICATIONS IN FUTURE

Modern classrooms and education system are technology based operations that facilitates systematic teaching and learning methods, 3D presentation, demonstration of practical examples in the realistic manner. All the facilities are ensured by the ICT in classroom with the help of eco-friendly computer hardware to ensure green computing practices (Enakrire, R.T, 2019) (Anthony, B., Kamaludin, A., Romli, A. et al., 2019). The present research study was the small initiative to mark the footprint on Green Computing for developing and implementing the ICT in classroom (Mirabolghasemi, M., Choshaly, S.H. & Iahad, N.A., 2019). The outcomes of the research study indicate the significance of green computing initiatives that finally trace the concept of Sustainable Society through younger generation. The present study can become the complement of new government policies on digital

education system that can address and connect the large population in diverse geographical locations in India.

### 5.1 Limitations and Future Research

The researchers initiated to identify the impact of Green Computing practices on ICT Based Teaching and Learning (ICT-BTL) Tools which have the universal demand and applicability. The respondents were selected from few big cities in India and considered as the representatives of rest of the population which is the major limitation of the present study. Because of high installation and maintenance cost of ICT based teaching and learning methods, the sub-urban and rural students may not be connected and benefited. The respondents from metro cities may not be the actual representatives of rural population for using the (ICT-BTL) Tools. Electronic mode of data collection procedures have utilized and personal observation of the respondents were missing. The respondents were selected from diverse background but could be better to add some more categories of respondents as representative of whole population. The initiatives of present study open up the new window of identifying and analyzing the updated ICT-BTL activities which are more suitable for next generation.

### 5.2 Conclusion

Green computing initiatives bring the revolutionary changes of implementing expertise in classroom activities for institutions and training centers (S K Podder, Shalini R, Debabrata Samanta 2019). ICT can assist for the smart function related to strategic policy and development of maintain Quality ICT-BTL activities (Boud, D, et al.1993), (Boyle, et al.2019). The present study concludes the positive impacts of developing and implementing the green computing in class rooms for the generation next students. The creation of consistent methods of Institution performance builds the good reputation of the organization and simultaneous substitute (Taryn L. S., & Christine M. B., 2015).

The teaching fraternity is shifting from traditional methods of teaching to digital mode of classroom activities. The digitally-enabled classroom is the systematic arrangement of computer, projector, and smart board for writing and recording day to day classroom activities (Mirabolghasemi, M., Choshaly, S.H. & Iahad, N.A., 2019) (S K Podder, Arun B K 2018).

We all are witnesses of conducting various activities in the classroom with the presence of teachers and students. Similarly, ICT-BTL systems can be engaged in the teachers and students to perform various activities in the virtual platform (Willans, et al.2019).

ICT-BTL system creates better opportunities for institutions to offer various professional courses all over the world. With the consideration of global education standards and requirements, the top education institutions are commencing the digital model of the education system (Myunghee k., et al. 2011), (Nilanjana D., et al. 2016).

Implementing ICT based classroom and green computing practices are the fundamental duties of the modern education system. Advanced managerial functions include planning, organizing, coordinating, and controlling administrative operations at an advanced level that can identify and fulfill the imbalances of an effective education system (Perryman A, Seal T 2016), (Rafe V, Hosseinpouri R 2015).

Virtual Communication Technology is an essential component of ICT-BTL process. Both the service providers and learners need to ensure the advanced level of Communication Technology to participate, download, upload the digital content, and performing various online activities (Asikainen et al. 2019), (Billett, Paulina and Martin, Dona, 2018). Effective education system ensures systematic knowledge and recognition with certification. ICT-BTL not only guarantees the improvement of knowledge, but also issues the authenticated certificate which is recognized by all national and international organizations.

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*Suplab Podder is a Management Professional with rich experience in the field of Teaching, Content Development and Management Research. He is the Life Member of Management Teachers Consortium-Global (MTC Global). He obtained his Bachelor of Business Management (BBM) from Bangalore University, Bangalore. He obtained Master of Business Administration (MBA) from Newport University, 2006. He obtained another Master of Business Administration (MBA) from Allagappa University, Tamil Nadu. He is awarded Ph.D in Management from Bharathiar University, Coimbatore, India. He is presently working as an Assistant Professor of Management and Commerce Department in Dayananda Sagar College of Arts, Science and Commerce, Bangalore, India. His areas of interests are Human Resource Management, Outsourcing, Banking and Insurance, Managerial Economics, Marketing Management and Strategic Management. He has published 24 books and published 6 Research Papers. He has attended and presented research papers.*

*Debabrata Samanta is presently working as Assistant Professor, Department of Computer Science, CHRIST (Deemed to be University), Bangalore, India. He obtained his B.Sc. (Physics Honors), from Calcutta University, Kolkata, India. He obtained his MCA, from the Academy of Technology, under WBUT, West Bengal. He obtained his PhD in Computer Science and Engg. from National Institute of Technology, Durgapur, India, in the area of SAR Image Processing. He is keenly interested in Interdisciplinary Research & Development and has experience spanning fields of SAR Image Analysis, Video surveillance, Heuristic algorithm for Image Classification, Deep Learning Framework for Detection and Classification, Blockchain, Statistical Modelling, Wireless Adhoc Network, Natural Language Processing, V2I Communication. He has successfully completed five Consultancy Projects. He has received funding under International Travel Support Scheme in 2019 for attending conference in Thailand. He has received Travel Grant for speaker in Conference, Seminar etc for two years from July, 2019. He is the owner of 17 Indian Patents. He has authored and coauthored over 133 research papers in international journal (SCI/SCIE/ESCI/Scopus) and conferences including IEEE, Springer and Elsevier Conference proceeding. He has received "Scholastic Award" at 2nd International conference on Computer Science and IT application, CSIT-2011, Delhi, India. He has published 9 books, available for sale on Amazon and Flipkart. He has edited 1 book available on GOOGLE BOOK server. He has authored and coauthored of 17 Book Chapters. He also serves as acquisition editor for Springer, Wiley, CRC, Scrivener Publishing LLC, Beverly, USA, and Elsevier. He is a Professional IEEE Member, an Associate Life Member of Computer Society of India (CSI) and a Life Member of Indian Society for Technical Education (ISTE). He is a Convener, Keynote speaker, Session chair, Co-chair, Publicity chair, Publication chair, Advisory Board, Technical Program Committee members in many prestigious International and National conferences. He was invited speaker at several Institutions.*