Techno-pedagogy Embracing Green ICT: A Formula for Accentuating Learning by Affirming Environmental Sustainability

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Abstract—*The advent of technology has brought about innumerable developments and innovations accelerating growth and development in all aspects of life. Teaching and learning endeavours of 21st century have essentially been designed and implemented to meet the multifaceted demands of the dynamic contexts of education. New and improved means to curriculum transaction is the need of the hour to cope with the wide range of demands of the knowledge society. This has made teacher's role even more prominent as techno-pedagogue who infuses technological skills in teaching-learning endeavours for providing enriched experiences to the learners of the new age. The Information and Communication Technology (ICT) has become an essential part of human development, while the threats of these advancements have raised issues of sustainability. Hence it is imperative to adopt green ICT enabling green computing in teaching and learning endeavours for ensuring optimization of technological resources with minimum wastage reducing environmental footprints of ICT in education. This article gives insights on the need for techno-pedagogy embracing green ICT for fostering effective learning and accentuating environmental sustainability. The article gives an account of the conceptual frameworks of techno-pedagogy and Green ICT in education. The paper also focuses the need for embedding green ICT in techno-pedagogy and the procedure involved in it. Apart from this the article also elucidates the benefits and challenges of Green ICT in teaching. It also highlights the role of teacher in fostering green ICT practices through integrating green ICT in teaching and learning. In conclusion, this article highlights how the needs of learners can be fulfilled in sustainable ways through techno-pedagogical approach embracing green ICT in the dynamic educational context.*

Keywords: *techno-pedagogy, green ICT, environment, sustainability, education.*

1. INTRODUCTION

Technology has rightly revolutionized education in every aspect. However the impact of technology on life sustenance has made it imperative to adopt green ICT in educational endeavours. This has in turn escalated the demand for teacher professionalism among the teaching fraternity. The modern outlook of teachers as techno-pedagogue affirms the need for incorporating multifaceted skills and competencies in addition to the knowledge of content and methodology of teaching.

Education being one of the significant fields for addressing the issues of sustainability must take every effort to infuse green initiatives in all its aspects. One step towards this is to adopt techno-pedagogical approaches to teaching by incorporating green ICT. This paper provides insight on adopting techno-pedagogy by embracing green ICT for sustainability.

2. BACKGROUND OF TECHNO-PEDAGOGY AND GREEN ICT

The process of education in the era of technological advancement and knowledge explosion has posed innumerable demands and challenges. Integrating ICT in education has improved the outlook of education as being 'smart' enhancing the teaching and learning endeavours. Integration of technology became vital for the enhancement of quality and pace of teaching and learning. It is also very essential for developing heightened interest, creativity and motivation among learners for effective learning. In a sophisticated and ever dynamic educational context, it became an essentiality to make the teaching – learning process more realistic and simple. The introduction of ICT in education has transformed the roles of teacher and learner. Thus, techno-pedagogy rightly has a potential for addressing the dynamic needs of learners as well as enhances the scope of teacher professionalism.

Sustainability has been a buzz word in the modern era of technological development and innovations. As the UN's 1987 Report of World Commission on Environment and Development [7] has rightly noted it as the meeting of the needs of the present without compromising the well being of future generations. Sustainability has been all pervasive and covers socio-economic and environmental dimensions. Going green is a way of taking up responsibility towards the environment for affirming sustainability. Green computing began in the 1990s with the launching of Energy Star certification program by the US Environmental Protection Agency (EPA). Moreover, the SMART 2020 report [8] have highlighted the potential of the ICT sector to keep check and control on the environmental foot prints as well as exercise

efficient energy management leading to a considerable reduction of the prevailing environmental foot prints of the sector. Green ICT is about reducing the environmental impact of ICT by developing and implementing it in an environmentally efficient and sustainable manner. It involves adopting ecofriendly practices while planning, using, implementing, and disposing complying with environmental regulations at all phases.

3.   CONCEPTUAL FRAMEWORK

3.1. Techno-pedagogy

There is a vital need for a teacher for being fully conversant with the most modern technology and techniques for addressing the needs of the advanced technological era. It was Schulman [5, 4] who described how teachers' knowledge about educational technology and pedagogical content fosters effective learning. Based on this, the Technological and Pedagogical Content Knowledge (TPACK) was proposed by Mishra and Koehler [2]. The three main components in this model include content, pedagogy and technology as depicted in Fig. 1 below. Teacher as a techno-pedagogue intelligently combines technology with pedagogy that is most appropriate for teaching a particular content. Thus, techno-pedagogy focuses on three prime areas of knowledge like the content, technology and pedagogy. Content pertains to the subject matter to be taught to the learners. Technology combines all the scientific and technical innovations and developments used for practical purposes like computers, internet, projectors, application softwares, computer networks, podcasts, conferences, etc. Pedagogy reflects the collective aspects of teaching and learning encompassing the methods, techniques, strategies and processes. In addition, it also includes knowledge about the aims and objectives of teaching and learning along with the assessment and evaluation of the entire teaching and learning process. Techno-pedagogical skills and competencies equips teachers to take the teaching and learning to new heights for conquering broader horizons and to be a professional in the orbit of excellence.
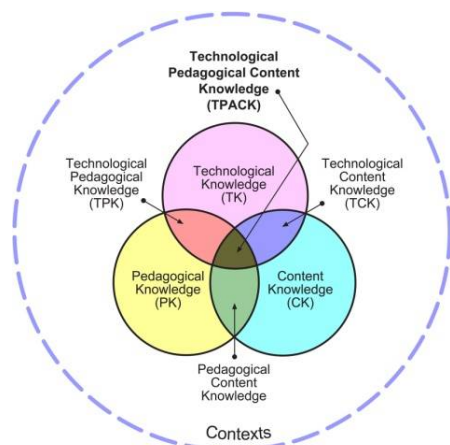
**Fig. 1: Knowledge components of TPACK
(Koehler & Mishra, 2009)**

3.2. Green ICT

The applications of ICT are scaling so high that its impact on society and environment has been far reaching raising issues of sustainability. Going green is a way of life wherein people adopt ecofriendly ideas for living. It has now become unrealistic to think of education without technology. According to Murugesan [3], green IT encompasses green use, green disposal, green design and green manufacturing. Drawing from this, green ICT may be thought of as the planning, designing, implementing, utilising, disposing and evaluating the ICT related activities from an environmental perspective inorder to reduce the impact of environment. It mainly focuses on energy efficiency and proper utilization of equipments and services of ICT. It also involves minimization of e-waste and utilization of non-hazardous materials in the manufacture of electronics and computer peripherals. Apart from this, it also includes the reduction of carbon dioxide emissions and addresses the problems of e-waste resulting from the disposing of unwanted and obsolete computers. Thus the green ICT is geared towards safeguarding sustainability.

4.   NEED FOR EMBEDDING GREEN ICT IN TECHNO-PEDAGOGY

The world of work is going ubiquitous where anyone can access, share and exchange a wide variety of information anywhere and anytime. The educational processes are also not far behind in utilizing technology for its day to day endeavours. Green ICT has opened avenues for green computing with minimum detrimental input on the environment. In this process, the role of teacher is magnificent in crafting and setting the apt conditions in order to create an amicable environment for learning while focusing on the wider aim of education for sustainability. At the outset, the National Curriculum Framework (NCF) [6] has rightly pointed out the need for linking knowledge to real life. This calls for providing realistic experiences and environments for effective learning. Techno-pedagogical approach that involves integration of green technology in teaching-learning process is a way to build such realistic situations for providing enriched experiences.

There has been a paradigm shift in the role of teacher and learner in accordance with the changing contexts of education across the world. The NCF has affirmed the vitality for shifting from mere rote learning method to an improved method of constructing knowledge. By integrating ICT in teaching, teachers' method of teaching shifts from a mere behaviourist mode to a constructivist mode. This provides amicable platform for the learners to be more creative and innovative whereby they construct knowledge with higher degrees of interest and motivation towards learning. By embedding green ICT in teaching, the teacher invariably conveys an extremely important message to the teaching and learning community about the grave need for prioritizing education for sustainability.

The NCF has raised the need for providing a wide range of experience for the holistic development of an individual. Techno-pedagogical approach infusing green ICT rightly is a means for fostering holistic development of an individual. Techno-pedagogical approach provides avenues for incorporating a wide range of information and experiences in teaching-learning endeavour. It can bring the real world experiences and situations into classroom through virtual media which otherwise would be impossible. Moreover facilities like webcasts and podcasts enables to access, exchange, analyze and share enriched knowledge across the globe. Adoption of green ICT facilitates the learners to acquire adequate knowledge and skills with regard to green computing to reduce environmental footprints and adopt sustainable lifestyles that add on to the holistic development of an individual.

Techno-pedagogy embracing green ICT not only makes the teaching and learning flexible, but also makes the assessment and evaluation fast and easy using ubiquitous facilities enabling effective and efficient utilization of resources with minimum wastage or damage to the environment. Technology enables teacher to evaluate learners based on continuous and comprehensive basis. Teacher can plan, design and implement online data recording systems and conduct tests online on a real-time basis. In totality, techno-pedagogical approach to teaching and learning opens up vast possibilities for innovations and collaborations in the worldly affairs of education heightening the spirits of inquiry and the development of ethical and social values.

5. TECHNO-PEDAGOGY EMBEDDING GREEN ICT IN CLASSROOMS

The procedure for adopting green ICT incorporated techno-pedagogy is enumerated below.

Planning Phase

This phase encompasses preparation of plan with regard to the content to be taught in terms of desired learning outcomes with clear cut specification on the appropriate choices of teaching methodology and activities that could be included for attaining the learning outcomes. Plan for optimized technological performances embedding green ICT in the teaching and learning processes with the number of technological devices to be put to use, the ways of power management for reducing energy consumption, utilization of energy efficient technologies, etc.

Design Phase

The design phase includes preparation of the lesson transcript in terms of learning outcomes. Choose from among the alternatives the best methodology of teaching content and the best technology suited for transacting the content so as to attain the learning outcomes with maximum optimized functionality of the resources ensuring minimum wastage and environmental impact. This encompasses incorporating optimal use of technology in terms of number of devices to be used, setting the devices to power saving modes, incorporating technologies that are energy efficient with less emission and using of non-hazardous materials in its manufacture for reducing the environmental impact of ICT.

Implementation Phase

This phase involves actually putting the plan in to action in the classroom teaching context. Here the teacher as a techno-pedagogue transacts the curriculum content according to the activities designed with proper utilization of the knowledge of content by following the best pedagogy of teaching the content by means of the best technological support for attaining the learning outcomes. The whole process is implemented according to the previously crafted activities whereby all the resources are utilized at its optimized performance level of green computing so as to minimize the environmental impacts of ICT. For this the teacher utilises optimum technology in terms of number of devices, turning off the system while not in use, switch to power saving modes like sleep mode and use of screen savers and energy efficient devices for reduced energy consumption and reduced emissions for minimum detrimental impact of ICT on the environment.

Evaluation Phase

This phase involves the evaluation of teaching and learning processes in a holistic manner. The teacher analyzes each and every situation so as to evaluate the effectiveness of teaching in terms of presentation of the content knowledge, the appropriateness of the teaching methodology followed for the content transaction, and the utilization of the best technology for transacting the content. In addition to this, the teacher also evaluates the level of optimization of technological performance in terms of utilization of technology in the most energy efficient manner.

Post Evaluation Phase

On the basis of the evaluations, the teacher seeks to enhance the quality of teaching and learning by adopting better ways of implementing the techno-pedagogical approach by integration of green ICT. The post evaluation phase comes up with much better alternative ways of techno-pedagogy embedding green ICT for attaining learning outcomes in the best possible manner with reduced impact of technology on the environment.

6. BENEFITS OF INTEGRATING GREEN ICT IN TEACHING

There are several benefits of integrating green technology in teaching. Some of them are given below.

1. *Enhances Quality:* Green ICT integration in teaching enables the provision of clean and healthy environment for the holistic development off learners for collaborative

and innovative learning. It enhances the quality of learning outputs in terms of attainment of learning outcomes in the most efficient ways by providing enriched educational experiences to learners by adding the environmental dimension of teaching and learning. It also provides realistic opportunities for green ICT practices through hands-on experiences to learners.

2. *Flexibility:* Integration of green ICT in teaching ensures flexibility of learning by paving way for blending the technology, methods and techniques in the most appropriate manner as per requirements of teaching, learning measurement and evaluation.

3. *Economy of Cost, Time and Energy:* Embedding green ICT in teaching helps in the reduction of operating cost and consumption of energy as a result of technology integration. It also saves teaching time by making the concepts and ideas clear and simple enabling the students to learn easily.

4. *Environmental Dimension:* Green ICT in teaching provides an environmental dimension to 'smart' way of teaching and learning. It conveys the valuable message of the vital need and importance of environment and natural resources for addressing environmental sustainability.

5. *Ecofriendly:* Green ICT helps in reducing the environmental footprints arising out of impact of ICT in teaching and learning endeavours. It enables the reduction of greenhouse gases and other hazardous substances thereby reducing environmental pollution and thereby contributing towards conservation, preservation and protection of the environment.

6. *Green Lifestyles:* Green ICT in teaching promotes the adoption of green lifestyles among the teaching and learning community for improving the quality of living. It emphasizes the essentiality of adopting green initiatives in this rapid developing world and enables the popularization of sustainability ideas through the adoption of ecological designs in teaching and learning.

7. *Security:* Teaching with green technologies ensures the safety of large volumes of data and information relating to teaching, learners, measurement and evaluation by means of secure passwords and data encryption facilities.

8. *Global Citizenship:* Green ICT in teaching fosters global citizenship through developing knowledge, skills and competencies along with social and ethical values of using green technologies and adopting green computing practices for safeguarding the future.

7. CHALLENGES OF EMBEDDING GREEN ICT PRACTICES IN TECHNO-PEDAGOGY

Some important factors that pose challenge in the embedding of green ICT practices in techno-pedagogy are summarised below.

1. *Lack of Awareness on Green ICT Practices* is one of the problems that pose challenge in incorporating green ICT in teaching and learning contexts.

2. *Lack of Technical Know-how of Green Computing* restricts the using, implementation and maintenance of green ICT in the educational settings.

3. *Lack of Efficiency in Managing the Resources* results from the lack of technical know-how and proper maintenance which in turn reduces the optimum functionality of technological resources.

4. *High Cost of Implementation* is incurred for setting energy efficient ICT and hence the large scale use of such facilities are often less in the infrastructural settings of educational institutions.

5. *High Cost of Maintenance:* The cost of maintenance of green ICT is very high which makes it difficult to properly maintain the technological systems that are very much essential for ensuring its proper functionality. For this reason the educational institutions are often reluctant to include green technologies on a large scale basis in its infrastructure.

8. ROLE OF TEACHER AS A TECHNO-PEDAGOGUE IN FOSTERING EFFECTIVE LEARNING AND GREEN ICT PRACTICES

1. Setting clean and healthy environment for effective learning and to foster green computing practices among learners.

2. Providing ample opportunities for active learning wherein learner engages in construction of knowledge in a blended learning environment that utilizes a variety of information and resources.

3. Fostering higher order thinking capabilities among the learners through scientific inquiry by providing realistic learning environment using green technologies.

4. Developing a sense of need for using technology in the most energy efficient manner so as to minimise the environmental impact thereby contributing towards preserving and conserving valuable resources.

5. Motivating learners by providing interesting learning experiences that fosters the spirit of enquiry along with cooperative and collaborative learning.

6. Developing knowledge, skills and competencies along with social values and ethics for global citizenship.

9. CONCLUSION

Teachers play a pivotal role of facilitator of learning opening new vistas of knowledge and enriched experiences to the learning community. The innovative utilization of technology in teaching has a vast potential for solving multifaceted

problems in the field of education. Embedding green ICT in teaching enables the teacher to affirm the need for addressing environmental sustainability. The teacher should seek effective utilization of technology in the most efficient manner in combination with the most appropriate pedagogical approach for the attainment of learning outcomes directed towards holistic development of learners for being the face of the new age.

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