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Environmental impact of paper consumption in the educational sector and digital learning - examination system post Covid-19

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ABSTRACT

In recent years, digital learning and examination system has received great importance in the educational sectors due to the present COVID-19 pandemic situation. This online digital learning and examination system had many advantages over the traditional paper-based offline system. Since the amount of paper consumption is very less in the digital online education and examination, this approach could be ideal for saving the tree and reducing the environmental risks. Moreover, digital learning and examination system could be more convenient, time-consuming and safe in the current COVID-19 pandemic. This paper describes the environmental impact of traditional education and examination systems, different types of tools available for conducting online education and assessments and strategies to minimize paper usage in the teaching-learning and examination systems.

Key words: *Paper consumption, Environmental impacts, Digital learning, Software tools, Conservation of trees.*

Introduction

The recent corona pandemic had forced the educational institutions to move the teaching-learning process online. By doing so, the COVID-19 pandemic had shaken the well-established routines in pedagogy. The traditional paper-based examination in educational institutions consume large volumes of paper, which leads to rapid deforestation. The chemicals used in the manufacturing of paper and ink cause potential damage to the environment while decomposing. Conducting a traditional method of examination involves many time-consuming procedures. Problems arise in question paper setting, publishing results and subsequent storage of the answer scripts before and after evaluation. The digital mode of examination is an ideal way to save the environment. The approaches to learning through digital forms, submissions of answer scripts and its subsequent analyses become excessively simple. Added to this, it brings about a welcome change in the global scenario, post the COVID-19 pandemic. This paper discusses the environmental impact of depletion of trees due to the large consumption of papers for traditional teaching-learning and evaluation systems, the software and hardware tools to conduct online assessments and the possible strategies to reduce the paper consumption in the educational sectors.

Depletion of Trees in India – Recent Scenario

Deforestation is a major threat that disturbs the ecosystem and creates adverse effects on earth. Trees generally play a major role in climate control, and the devastation to trees poses a serious threat on human life and the environment. According to the tree

cover loss data for India (Rhett, 2020), tree cover extent (threshold 10%) in India was about 49.2 million hectares (15.6% of total land area) in 2000.By 2010, it was reduced to 43.4 million hectares, which is about 13.8% of the total land area. By the end of 2018, the total area under tree cover extent was reduced to 42.3 million hectares (13.4% of total land area). These data revealed that India has lost over 6.84 million hectares of tree cover between 2001 – 2018, which is about 3.6% of tree cover loss since 2000. If such a trend of tree cover loss continues, the tree cover extent in the country would be reduced to as low as 37.7 million hectares by the end of 2030. Increasing population, industrialization, urbanization, road construction, mining and other developmental activities could be deemed as the major reasons behind the depletion of trees in India. Due to the depletion of trees, life-supporting systems such as microclimatic conditions, soil quality, hydrological cycle and biodiversityof the country are perturbed, thereby making the country more susceptible to some detrimental consequences. Reduced paper consumption is one of the significant measures that can be embraced to reduce the rate of depletion of trees.

Consumption of Papers and its Environmental Impact

Traditional teaching-learning, evaluation and examination systems in the educational institutions consume a large number of papers and consequently impact the environment directly or indirectly. Table 1 shows the estimated amount of papers and its equivalent quantity of trees consumed every year for conducting the teaching-learning and assessment processes in India. As shown, the annual students' registration for upper primary to higher secondary in Central Board of Secondary Education (CBSE), Indian Certificate of Secondary Education (ICSE), National Institute of Open Schooling (NIOS) and other state board schools are about 11.4, 1.1, 6.4 and 112.3 million, respectively (Eduncle, 2019). It is estimated that about 1400, 500 and 150 sheets of A4 papers have been consumed by each student every year for notebook, textbook and assessments, respectively, which gives the total paper consumption of 116.8, 11.3, 65.6 and 1151 kilotons/year by the CBSE, ICSE, NIOS and State Board Schools, respectively (assuming that the weight of 500 A4 sheets is equivalent to 2.5 kg). As depicted in Table 1, the number of students enrolled in the tuition/coaching centres is estimated at 74 million/year. If we consider that each student consumes about 500 A4 sheets annually for both notebook and assessments, it accounts for a total paper consumption of 185kilotons/year. According to the report by Ministry of Human Resource Development (MHRD, 2018), the students' enrolment in colleges/universities/training institutes has increased from 29.18 million in 2011-12 to 36.6 million in 2017-18. The overall growth is estimated at 25.4%. It is also determined that the students' enrolment in colleges/universities/training institutes is increasing by about 2.5% every year. Based on these data, as shown in Table 1, the estimated number of students registered in the colleges/universities/training institutes is about 174 million/year. If we consider that the average number of A4 sheets consumed by these students is about 1400, 1000 and 150/year for notebook, textbook and assessments respectively, it amounts to a total paper consumption of about 2349 kilotons/year. It is appraised that about 24 million students are appearing for competitive examinationevery year in India, which accounts for about 3.7 kilotons/year of paper consumption in terms of applications, instruction sheets, question papers and answer scripts. Based on the data given in Table 1, the total paper consumption for teaching-learning, assessments and competitive examinations in India is about 3882.5 kilotons/year. From this, about 20% of paper is derived from the recycling of the waste papers (Rumani, 2015). The remaining 80% of paper, which is about 3106 kilotons, is produced from the wood. It is measured that about 3.47 tons of wood, roughly equivalent to 24.29 trees, is consumed to produce 1 ton of A4 papers (World Atlas, 2018). Accordingly,75.44 million trees are utilized every year toproduce 3106 kilotons of A4 papers required for educational institutions and other organizations that conduct competitive examinations in India.

The destruction of a large number of trees to produce papers has resulted in habitat damage, biodiversity loss and aridity in India. Also, it caused a serious threat to human life, extinction of native species, climate change, desertification and increased greenhouse gases in the atmosphere (Mukete *et al*., 2016). Due to the large consumption of papers in the teaching-learning and examination systems, huge amounts of used paper is discarded in the gorges, dustbins, street corners and water bodies. This discarded paper could be potentially carcinogenic when incinerated or mixed with

groundwater due to the presence of toxic inks, dyes and polymers. Moreover, the toxic chemicals such as chlorine, mercury, absorbable organic halogens, nitrates, ammonia, phosphorus and caustic soda that are used during the paper-making processes could cause several environmental risks. Disposal of discarded paper in landfills could also generate methane that is responsible for greenhouse effects as it decomposes. It is found that the amount of methane formed by paper in landfills is about 70 times higher than that formed by thermal power plants utilizing fossil fuel. These statistics indicate the extent of depletion of trees due to paper consumption and its adverse effects on the environment. To reduce the paper consumption in the educational sectors and prevent the depletion of trees and environmental risks, online teaching-learning and paperless digital examination systems could be the best alternative. By reducing the paper consumption through online practice, India could save approximately 1553 million US$ and earn about 2.2 million carbon credits every year. This article is proposing a strategy to reduce paper consumption in the educational sector in various phases.

Strategies to Reduce Paper Consumption in Educational Institutions

The major portion of paper consumption in the educational institutions includes textbooks, notebooks and assessments. As per Table 1, there are around 131.2 million school students and by considering, the number of papers utilized for the textbooks is 500 per student per year, then the usage of paper towards textbooks is 328 kilotons/year. The total paper consumption in schools for teaching-learning alone is 1344.8 kilotons/year. And, in colleges and universities, the total paper consumption towards the teaching-learning process is 2349 kilotons/year. Firstly, it is necessary that the educational institutions ensure the availability of necessary infrastructure to offer a digital mode of the teaching-learning process such as Learning Management System (LMS) equipped with an assessment tool, online learning applications and tools. Instead of printed version of textbooks, educational institutions can issue some extent digital version of textbooks to the

Table 1. Consumption of papers for teaching-learning and assessment processes.

Organisation		Strength of Students, Million/year (Approximate)	Paper consumption(A4 size)	
			Purpose	Kilotons/year
Schools	CBSE	11.4	Notebook	79.8
			Textbook	28.5
			Assessment	8.5
	ICSE	1.1	Notebook	7.7
			Textbook	2.7
			Assessment	0.82
	NIOS	6.4	Notebook	44.8
			Textbook	16.0
			Assessment	4.8
	State boards	112.3	Notebook	786.0
			Textbook	270.7
			Assessment	84.2
Tuition/Coaching centres		74.0	Notebook	148.0
			Assessment	37.0
Colleges/Universities/ Training Institutes		174.0	Notebook	1218.0
			Textbook	870.0
			Assessment	261.0
UPSC/SBI/PSU/IAF/RRB/SSC/ IIT/NTA/AIIMS		24.4	Competitive examination	3.6
		Total paper consumption		**3882**
		Equivalent number of trees		**94.3 million**

[*Abbreviations:* UPSC - Union Public Service Commission, SBI – State Bank of India, PSU - Public Sector Undertaking, IAF - Indian Air Force, RRB - Railway Recruitment Board, SSC - Staff Selection Commission, IIT – Indian Institute of Technology, NTA - National Testing Agency, AIIMS - All India Institute for Medical Sciences]

students. Assessments can go online and iPads, tablets or other mobile devices can replace notebooks. Submission of assignments and practical record notebooks can be in digital format. The recent technological advancements make this initiative possible.

Table 2 and 3 gives the transformation statistics of phased manner implementation of paperless teaching-learning in CBSE and government schools by considering 1000 students in each category. The annual paper consumption in a paper-based system is 10.25 tones/1000 students. Implementing the paperless teaching-learning and examination system in CBSE schools especially in private schools is easy as the policy decision to be taken is by the single entity, i.e., the management of the schools. The internet connectivity is essential in the digital mode of the teaching-learning system, which may not seem as a major concern in CBSE schools that are mostly located in towns and cities. The students of CBSE schools can bring devices to the schools and do their homeworks and assignments online. Since CBSE schools have adequate infrastructure and financial sustenance, they can effectively implement the paperless teaching-learning system within the coming three years. Table 2 depicts the way by which the CBSE schools may implement the digital mode of teaching-learning system in year-wise to reduce the annual paper consumption. In the first year, by transforming 30% of the textbooks into the electronic form along with conducting the digital mode of examination for the internal assessments, the overall paper consumption can be reduced to about 15%. Besides, the record notebooks for the practical courses can be submitted in electronic forms such as word document or pdf form in the second year, which will further reduce the paper consumption by 40%. In the third year, incorporation of digital mode of examination in board exam along with the use of iPads, tablets or mobile devices to replace notebooks will reduce paper consumption by 70%. If this trend continues in subsequent years, paperless teaching-learning process can replace about 80% paper consumption in the CBSE schools.

Contrary to the above scenario, the government schools that are located in rural areas is likely to suffer without the mentioned infrastructure facilities. It is estimated that over 85% of the schools have a lack of internet connectivity and suffer from frequent power failures. Hence, the successful implementation of the paperless teaching-learning process in government schools will be quite challenging and may take more than three years. Table 3 shows the strategy by which government schools may implement the digital mode of teaching-learning system year-wise to decrease paper consumption.In the first year, 10% of the textbooks need to be issued in electronic form along with the online internal assessment, which will reduce paper consumption by 10%. In the second year, issue of the printed version of the textbooks needs to be reduced to 80%, which will further decrease the overall paper consumption by 13%. In the subsequent years, the paper consumption can be gradually reduced to 15%, 40% and 70% by conducting online assessments along with transforming 30% of the books into electronic form, encouraging the students to submit the practical record online and developing the infrastructural facilities in the schools. This phase-wise implementa-

Table 2. Strategy to reduce paper consumption in CBSE schools (for 1000 students).

Sl. No.	Category	Year		
		1	2	3
1	Strategy for paper consumption	30% Digital version of textbooks + online assessments	30% Digital version of textbooks + online assessments + electronic form of practical records	30% Digital version of textbooks + online assessments + electronic form of practical records + iPads/tablets/ mobile devices in place of notebooks
2	Reduction in paper consumption, tones/year	1.5	4.0	7.0
3	Reduction in paper consumption, %	15	40	70

tion of digital teaching-learning may lead to a greater extent of paper consumption in the educational sector and reduce the burden of students and institutions during the digital transformation.

Challenges for Online Education in Schools

There are pragmatic challenges that one needs to take notice of to enforce a system of harmonious digital learning. Some of these concerns range from technical glitches in software to regular power shortages that need to be rectified constantly. From a macroscopic societal point of view, the students need to become well-versed and the teachers need to be flexible to impart these alternate learning styles. It is imperative that both these parties need to be exposed and thereby equipped with new technologies to constantly upgrade themselves. This can be imparted right from the primary schooling and track a proper growth curve in terms of a student's learning is concerned. These also act as proper feeds to get a hang of student's wishes and the industrial necessities and thus act as a proper bridge between them. This can be initially started as a uniform governmental venture in schools following CBSE, ICSE and NIOScurriculums; and other state board schools can impart this optionally. Thereby, a proper establishment of online learning can become a helpful tool to improve pedagogy in the future.

Examinations Post COVID-19 Pandemic

The widespread use of E-learning resources has become a significant takeaway during the times of COVID-19. While lockdown imposed by the government forced students and teachers to stay in their respective homes, it was through the use of various software applications that classes were conducted. With features like chats, PowerPoint slide sharing, usage of mics, the probable shortcomings of not able to physically connect with the students were more or less taken care of. In the wake of such revolutionary changes in pedagogy during this period, it is imperative to take a step forward and analyze how a widespread implementation of online examinations is also possible. The advantages of such examinationscould find its way to the college routine after COVID-19 and seamlessly pave way for the future learning.

Tools for Online Assessments

Software Tools

The recent advancement in the internet technology paves way for online assessment to replace the paper-based examinations. There are a large number of online assessment tools available to conduct the examinations securely (Software Suggest, 2020). These tools provide impartial evaluation which might not necessarily be the case in manual evaluation. Some of the important online assessment tools are Eklavya, Kaldin, TCExam, VirtualX, Edbase, Moodle, TAO and Papershala. Each of the software havetheir unique features and limitations. Several

Table 3. Strategy to reduce paper consumption in government schools (for 1000 students).

Sl. No.	Category	Year				
		1	2	3	4	5
1	Strategy for paper consumption	10% Digital version of textbooks + online assessments	20% Digital version of textbooks + online assessments	30% Digital version of textbooks + online assessments	30% Digital version of textbooks + online assessments + electronic form of practical records	30 % Digital version of text books + online assessments + electronic form of practical records + iPads/ tablets/mobile devices in place of notebooks
2	Reduction in paper consumption, tones/ year	1.0	1.3	1.5	4.0	7.0
3	Reduction in paper consumption, %	10	13	15	40	70

educational institutions that use Eklavya conduct assessment exams for student admissions and also for grading the students. Kaldinis an Open Source Online Exam Software, which provides services to schools, colleges and companies. Using this tool, the test can be taken by the users as per their convenient time and results can be declared instantly. TCExam is an independent, web-based online examination system. It is accessible to all including physically challenged people. This software has several topics and each topic has an unlimited number of questions. Each user can get an individual question paper by randomly selecting questions based on the level of difficulty and type, hence eliminate the risk of cheating by the candidates. Virtualx is another type of open source exam software that proposes perfect assessment solutions to educational institutions. Edbase offers complete test solutions to all levels of educational institutions and corporates. Using this software, assessment time is saved by 55% because of its user-friendly interface. Moodle is a popular open-source LMS used by many academic institutions. TAO is another open-source online examination software that offers a modular structure for collaborative test development. The main features of this software are subject management, group management and result management. Papershala is an open-source online testing tool that can run on desktop, tablet and mobile devices with various types of operating systems. It facilitates a large volume of question bank and a multifunctional database for the students to check their course-wise results and their performance.

Hardware Tools

The digital examination system (DES) and digital scanning and onscreen evaluation (DSOE) system are commonly used hardware tools to conduct the online examinations. The DES can be user friendly since it utilizes the input devices which permit applicants to write on paper or input devices such as digital pad and digital pen. Digital pad works in connection with cloud and permits candidates to write by a digital pen, share and save the written documents. A digital pen is convenient for users to generate handwritten files on a computer or laptop. The receiver attached to the pad can capture the movements of digital pens and store the written matter and diagrams drawn on the sheet.

In the DSOE system, initially, the answer sheets will be scanned in secure places. Then, the scanned answer sheets will be evaluated on computers/laptops/tablets by the exam cell for further onscreen evaluation process (Mukesh, 2021). In this system, the concerns related to secure transport of answer sheets, replacement of answer sheets, delay in assessments, etc. are reduced. Moreover, the time required for revaluation is greatly minimized as the answer sheets are readily available online and can be reassessed anytime by the examiners.

Hybrid Assessment Method

In the traditional paper-based examination system, 400 kilotons of A4 papers, which is equivalent to 9.6 million trees, have been consumed every year. The hybrid assessment method could be advantageous to reduce paper consumption and to retain the quality in the assessments. In the hybrid assessment, the question paper pattern can be modified to facilitate online assessment for a set of questions and the remaining to be assessed using the traditional paper-based method. Instead of conducting the assessment by writing all the answers in the paper, the answers for multiple-choice questions and short answers can be entered and assessed online using the online assessment tools. The answers for descriptive questions can be written in the A4 papers and uploaded after scanning in the online assessment tools for the evaluation. By conducting the hybrid method of assessments, paper consumption for the assessment could be reduced to half i.e., ~200 kilotons, thus saving about 4.8 million trees.

Online Practices at Hindustan Institute of Technology and Science (HITS)

The Covid-19 pandemic has caused an unprecedented public health emergency affecting the functioning of every sector and causing the closure of schools and higher education institutes. In the wake of this emergency, educational institutes around the world are shifting their operations to online teaching-learning procedure. HITS, a premier institution in Engineering and Technology, Chennai, India, has stopped its offline operations and shifted to teaching-learning and evaluation procedure online for 32 undergraduate and 16 postgraduate programs that comprises about 7200 students and 500 faculties in various disciplines. This process was done with the help of online tools such as Microsoft Teams, Google, Edmodo, Moodle, Skype, Zoom, etc. in the even semester of academic year 2019-20. The study materials were made available on the faculty and

Moodle's website by the respective teachers of all the Departments. All the final year students pursuing engineering, arts and science, MBA and MCA courses submitted the soft copy of project report to the institute via online and their viva-voce examinations were conducted using Microsoft Teams. The end semester examinations were conducted by sharing multiple-choice and descriptive questions with the help of Moodle and Microsoft Teams. Due to the online teaching-learning, evaluation and examination processes conducted by HITS, students attended classes comfortably and appeared for the examination from their homes without stress and unnecessary travel. Moreover, about 48 tons of A4 paper sheets, which is roughly equivalent to 1154 trees, were saved.

Conclusion

Presentlythe educational sector around the globe has moved to an online digital mode of teaching in response to the Covid-19 virus outbreak. Also, the pandemic has presented possible opportunities for conducting online-based examinations in the road ahead. Online education has not only enabled the safety of students and staff but also reduced the usage of paper in the teaching-learning process. This paper has discussed the extent of paper consumption by the educational sectors of India and its effects on the environment, plansto avoid or minimize the usage of paper in the schools by adopting online digital technologies, and methods to conduct the teaching and examinations online. In India, about 3882 kilotons of papers/year, which is roughly equal to 94.3 million trees, are consumed by educational institutions and various other organizations that conduct offline competitive examinations. It is estimated that through reduced paper consumption in online practice, as much as 1553 million US$ can be saved- earning about 2.2 million carbon credits every year. Thus, by implementing a hybrid system of teaching-learning, assessments and examinations online, a quality and harmonious education can be provided without compromising the environmental issues associated with depletion of trees and disposal of wastepaper. Having adopted such techniques and meeting with considerable success in this period, the focus is now on evolving these systems in a holistic view as per the future requirements of pedagogy.

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