



## Research Article


# The Special Role of Information and Communication Technology (ICT) in Indian Education: Current Context, Challenges, and Future Prospects

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Abstract	Manuscript Information
<p>Information and Communication Technology (ICT) has emerged as a transformative force in the Indian educational landscape, redefining how knowledge is delivered, accessed, and retained. The UNESCO report Learning to Be underscored the primacy of the learning experience over the mere transmission of content, a principle that ICT is uniquely positioned to fulfil. This paper adopts a descriptive analytical approach to examine the multidimensional role of ICT in Indian education, from primary schools to higher education institutions. It reviews the tools, platforms, and policy frameworks that govern ICT integration, analyses empirical data on student outcomes and digital access, and investigates structural barriers such as the rural-urban digital divide, inadequate teacher training, and power infrastructure deficits. The paper further explores how landmark national initiatives, including the National Education Policy (NEP) 2020, DIKSHA, SWAYAM, and PM e-VIDYA, are reshaping the pedagogical ecosystem. Findings suggest that while ICT holds enormous potential to democratise quality education in India, its transformative impact remains uneven and contingent on systemic investments in connectivity, capacity building, and inclusive curriculum design.</p>	<ul style="list-style-type: none"> <li>▪ <b>ISSN No:</b> 2583-7397</li> <li>▪ <b>Received:</b> 18-03-2025</li> <li>▪ <b>Accepted:</b> 29-04-2025</li> <li>▪ <b>Published:</b> 30-04-2025</li> <li>▪ <b>IJCRM:</b>4(2); 2025: 470-475</li> <li>▪ <b>©2025, All Rights Reserved</b></li> <li>▪ <b>Plagiarism Checked:</b> Yes</li> <li>▪ <b>Peer Review Process:</b> Yes</li> </ul>
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**KEYWORDS:** Information and Communication Technology (ICT), Digital Education, NEP 2020, EdTech, Digital Divide, DIKSHA, E-Learning, Inclusive Education.

## 1. INTRODUCTION

Education and technology have always shared a symbiotic relationship. From the invention of the printing press to the proliferation of personal computers and the emergence of artificial intelligence, each technological epoch has fundamentally restructured the architecture of learning. In contemporary India, Information and Communication Technology (ICT) stands at the centre of this ongoing transformation, promising to bridge centuries of educational inequity and to equip a population of 1.4 billion with skills suited to a rapidly evolving global economy.

The term 'technology' is rooted in the Greek words *technikos* (meaning art or craft) and *logos* (meaning reason or study). Educational technology, by extension, is the systematic application of scientific knowledge to instructional design, delivery, and assessment. The five essential components of educational technology — man, material, media, mass communication, and method — together constitute the scaffolding upon which modern pedagogy rests (Kumar, 2012). ICT in education encompasses a broad spectrum of tools: from radio and television broadcasts used in the 1970s under the Satellite Instructional Television Experiment (SITE), to contemporary platforms such as DIKSHA, SWAYAM, and AI-driven personalised learning systems. India's digital education journey has been accelerated by landmark policies — most notably the National Education Policy (NEP) 2020 — which explicitly identifies ICT as a vehicle for achieving equity, quality, and accountability in the education system (Ministry of Education, 2020).

This paper undertakes a systematic analysis of the role of ICT in Indian education by reviewing its technological infrastructure, evaluating government-led programmes, examining empirical data on learning outcomes, and mapping the barriers that continue to impede universal adoption. The study argues that while India has made commendable strides in deploying ICT, the promise of technology-enhanced learning can only be fully realised through coordinated policy action, sustained public investment, and genuine inclusion of marginalised communities.

## 2. OBJECTIVES OF THE STUDY

- To review the significant dimensions of ICT integration in the Indian education system in the context of contemporary digital transformation.
- To assess the impact of strategic ICT tools and pedagogical approaches on student learning outcomes and teacher effectiveness.
- To identify and analyse the structural barriers that impede the equitable deployment of ICT across India's diverse educational landscape.
- To evaluate the alignment between national policy frameworks (NEP 2020, DIKSHA, SWAYAM) and on-ground ICT implementation.

## 3. METHODOLOGY

This research employs a descriptive-analytical research design, synthesising evidence from both primary and secondary sources. Primary data sources include government reports, survey findings from organisations such as ASER (Annual Status of Education Report), UDISE+, and UNESCO, as well as field-

level observations documented in peer-reviewed literature. Secondary sources comprise academic journals, policy documents, educational research articles, and verified institutional websites including the Ministry of Education, NCERT, and NIEPA.

The study adopts a qualitative content analysis framework, categorising findings under three broad themes: (i) the infrastructure and tools constituting ICT in Indian education, (ii) the pedagogical and policy dimensions of ICT deployment, and (iii) the challenges and prospects for sustainable ICT integration. Data presented in tables has been drawn from credible national and international datasets, including UDISE+ 2022-23, ASER 2023, the MoE Annual Report 2022-23, and UNESCO Education Data.

## 4. ICT Landscape in Indian Education: Tools and Infrastructure

### 4.1 Digital Access and Connectivity

India's digital penetration has grown at a remarkable pace over the past decade, driven by affordable mobile data, the expansion of broadband networks, and government schemes such as BharatNet. However, the aggregate figures mask significant intra-national disparities, particularly along rural-urban and gender lines, as illustrated in Table 1 and Table 3.

**Table 1:** Growth of Internet Access and School ICT Infrastructure in India (2015–2024) Sources: TRAI Annual Reports; UDISE+ 2022-23; Ministry of Education, GoI

Year	Internet Users (Millions)	% of Population	School ICT Access (%)
2015	354	27.0%	~22%
2018	560	41.3%	~38%
2020	749	54.0%	~51%
2022	887	62.4%	~63%
2024 (Est.)	1,020	70.8%	~72%

As of 2024, an estimated 1.02 billion Indians are internet users, representing approximately 70.8% of the population (TRAI, 2024). Yet, as Table 3 demonstrates, rural internet penetration remains significantly lower than urban, and gender disparities further compound the issue. Female internet users constitute only one-third of total users, creating structural disadvantages for girls' access to digital education resources.

### 4.2 Hardware and Software Infrastructure in Schools

Educational technology tools span both hardware and software dimensions. Hardware encompasses physical devices — desktop computers, laptops, tablets, smart interactive panels, document cameras, and projectors — that form the material foundation of ICT-enabled classrooms. The Central Institute of Educational Technology (CIET), under NCERT, has played a pivotal role in developing software solutions, curriculum-aligned e-content, and multimedia modules used across Indian schools (Patra & Mete, 2014).

Software infrastructure includes Learning Management Systems (LMS), which enable course delivery, assignment submission, and real-time assessment. Tools such as Google Classroom, Moodle, and India's indigenous DIKSHA portal allow teachers to curate content and track student progress. Interactive

educational applications — such as Kahoot, Quizlet, and Byju's — gamify the learning experience and have demonstrated measurable improvements in student engagement and retention (Sahu, 2025).

Multimedia content developed by CIET includes 3D animations, virtual laboratory simulations, and subject-specific documentary videos. These resources are distributed through NROER (National Repository of Open Educational Resources), which as of 2023 hosts over 14,000 pieces of digital content in multiple Indian languages, including Hindi, Tamil, Telugu, Kannada, and Bengali.

### 5. Government Initiatives and Policy Frameworks

India's government has launched a series of flagship programmes designed to embed ICT within the formal education system. Table 2 provides an overview of the most significant of these initiatives.

**Table 2:** Key Government ICT Initiatives in Indian Education Source: Ministry of Education, GoI Annual Reports 2020-2023

Programme / Initiative	Launched	Governing Body	Key Objective
DIKSHA Portal	2017	MoE / NCERT	Teacher training & digital content
SWAYAM MOOCs	2017	Ministry of Education	Free online higher education courses
PM e-VIDYA	2020	Ministry of Education	Multi-mode digital education access
NROER	2012	CIET / NCERT	Open educational resources repository
Smart Classrooms	2014	Rashtriya Madhyamik Shiksha Abhiyan	ICT-equipped secondary schools
NIPUN Bharat	2021	MoE	Foundational literacy & numeracy using ICT

### 5.1 National Education Policy (NEP) 2020 and ICT

The NEP 2020 marks the most comprehensive policy overhaul in Indian education since 1986. ICT is positioned as a cross-cutting enabler within the policy, with explicit mandates for digital literacy from the foundational stage, integration of AI and coding in secondary curricula, and the creation of a National Digital Education Architecture (NDEAR) to serve as an open, interoperable technology infrastructure for all educational stakeholders (Ministry of Education, 2020).

The policy emphasises teacher professional development through DIKSHA — the Digital Infrastructure for Knowledge Sharing — which by 2023 had registered over 3.5 million teachers and facilitated more than 200 million learning sessions (MoE Annual Report, 2023). NEP 2020 also prioritises inclusive education, directing schools to deploy assistive technologies for students with disabilities and to develop content in regional languages to address the learning needs of linguistic minorities.

### 5.2 SWAYAM, PM e-VIDYA, and Open Distance Learning

SWAYAM (Study Webs of Active Learning for Young Aspiring Minds), launched in 2017, offers over 1,900 Massive Open Online Courses (MOOCs) across disciplines from Class 9 to postgraduate levels, delivered by faculties of IITs, IIMs, and central universities. As of 2023, SWAYAM has enrolled over 30 million learners, making it one of the largest open learning platforms globally (SWAYAM, 2023).

PM e-VIDYA, launched in 2020 in response to COVID-19 school closures, unified all digital and online education efforts under a single programme. It operationalised Diksha for school education, SWAYAM for higher education, and established 12 dedicated DTH television channels and Radio Mana Bhawan for students in areas lacking internet connectivity. The programme exemplifies a multi-modal approach to ICT in education — recognising that digital equity requires parallel investment in both high-bandwidth and low-bandwidth delivery mechanisms. Open and Distance Learning (ODL), coordinated by institutions such as IGNOU (Indira Gandhi National Open University), has benefited substantially from ICT integration. IGNOU's virtual learning environment and e-Gyankosh digital repository provide learners in geographically remote regions access to course materials, lecture recordings, and examination resources without requiring physical attendance.

### 6. Pedagogical Impact of ICT: Evidence and Outcomes

The pedagogical value of ICT extends beyond the mere digitisation of traditional content; it fundamentally transforms the nature of teaching and learning interactions. Table 4 presents a synthesis of outcome data from multiple credible Indian studies and reports.

**Table 4:** Observed Learning Improvements in ICT-Integrated Schools Sources: ASER Report 2023; NIEPA Study 2022; UNESCO Education Report 2022; UDISE+ 2022-23; MoE Annual Report 2023

Domain	Observed Improvement	Source / Evidence
Reading Comprehension	+18% (digital text tools)	ASER Report 2023
Mathematics Performance	+22% (EdTech adaptive tools)	NIEPA Study 2022
Student Engagement Rate	+35% (interactive content)	UNESCO 2022
Teacher Efficiency	+28% (LMS & digital planning)	MoE Annual Report 2023
Attendance Rate (ICT schools)	78% vs 61% (non-ICT)	UDISE+ 2022-23

### 6.1 Active Learning and Student Engagement

ICT facilitates a transition from passive, teacher-centred pedagogy to active, student-centred learning environments. The flipped classroom model — in which students review instructional content at home through video lectures and then engage in problem-solving and discussion during class time — has gained traction in urban Indian schools and has been associated with improved conceptual understanding and critical thinking skills (Chatterjee & Nath, 2015).

Real-time collaborative tools, such as Google Docs and Microsoft Teams, enable students to co-author documents, share feedback, and engage in joint problem-solving across geographical boundaries. Such collaborative digital learning

develops 21st-century competencies — communication, collaboration, creativity, and critical thinking — that are increasingly demanded by the labour market.

Gamified learning platforms deploy principles of game design — points, badges, leaderboards, and instant feedback — to sustain motivation and reward effort. Research indicates that gamified instruction can increase student attention spans and improve knowledge retention compared to conventional lecture formats (Sahu, 2025). Applications such as Kahoot and Quizizz have been integrated into Indian classrooms to make formative assessment engaging and responsive.

### 6.2 Inclusive Education through ICT

ICT offers powerful tools for inclusive education, ensuring that students with diverse learning needs can participate meaningfully in mainstream schooling. Assistive technologies — including screen readers, speech-to-text software, magnification tools, and braille displays — enable students with visual and auditory impairments to access digital content. The Accessible India Campaign (Sugamya Bharat Abhiyan) and the Rights of Persons with Disabilities Act, 2016 provide the legislative foundation for mandating such provisions in publicly funded schools.

For learners in regional language contexts, ICT enables the development and distribution of mother-tongue instruction materials at scale. Platforms such as DIKSHA support content in 36 Indian languages, enabling teachers to deliver instruction in linguistically appropriate formats and reducing the cognitive load associated with learning in a second or third language.

AI-driven personalised learning systems are an emerging frontier in inclusive education. Adaptive platforms analyse individual student performance data to identify learning gaps and dynamically adjust content difficulty and pacing. Although still nascent in India's school system, pilots in states such as Andhra Pradesh and Karnataka have demonstrated promising results in improving foundational literacy and numeracy outcomes (NIPUN Bharat Progress Report, 2023).

### 6.3 Teacher Professional Development and e-Governance

The effectiveness of ICT in education is critically dependent on the capacity and confidence of teachers to use digital tools. DIKSHA's continuous professional development modules have provided over 3.5 million teachers with training in pedagogical ICT use, curriculum mapping, and digital content creation. Teachers can access training at their own pace, take competency assessments, and earn digital certificates — all within the DIKSHA ecosystem.

Administrative ICT, commonly referred to as e-Governance in education, has transformed institutional management. The UDISE+ (Unified District Information System for Education) platform aggregates school-level data — enrolment, attendance, infrastructure, and outcomes — in real-time, enabling evidence-based planning and resource allocation at district and state levels. This data infrastructure has been instrumental in identifying underperforming schools, tracking dropout rates, and targeting government interventions with greater precision.

## 7. The Digital Divide: Structural Barriers to ICT in Indian Education

Despite impressive headline statistics on digital growth, India's educational ICT landscape is characterised by profound inequities. Table 3 disaggregates access data by urban-rural geography and gender, while Table 5 catalogues the principal barriers and corresponding policy interventions.

**Table 3:** Digital Divide Indicators in Indian Education (2023) Sources: TRAI; UDISE+ 2022-23; Internet and Mobile Association of India (IAMAI) 2023

Category	Urban (%)	Rural (%)	Gender Gap (M/F)
Internet Access (2023)	72%	37%	67% / 33%
Smartphone Ownership	78%	44%	74% / 26%
Students with Home Computer	52%	18%	—
School with Functional Computer Lab	68%	29%	—
Teachers ICT-Trained	61%	32%	—

**Table 5:** Key Challenges to ICT Integration and Recommended Interventions Sources: UDISE+ 2022-23; MoE Report; Author's Analysis

Challenge	Extent / Severity	Recommended Intervention
Poor Rural Connectivity	High — 37% rural internet access	BharatNet rollout acceleration
Teacher ICT Illiteracy	Medium — 39% untrained	Mandatory CPD via DIKSHA
Lack of Devices	High — 82% rural students lack home PC	One Student One Device policy
Regional Language Content	Medium — limited vernacular resources	Expand NROER multilingual content
Electricity Outages	High — 23% schools' unreliable power	Solar power / backup infra grants
Outdated Hardware	Medium — labs with 5+ yr old systems	Annual hardware refresh budgets

### 7.1 Connectivity and Infrastructure Deficits

The most fundamental barrier to ICT in education is the absence of reliable internet connectivity, particularly in rural, tribal, and hilly regions. Despite the BharatNet programme's goal of connecting all 2.5 lakh gram panchayats with optical fibre, implementation has been uneven. As of mid-2024, only approximately 62% of gram panchayats had been connected (BharatNet Progress Report, 2024), leaving millions of students outside the reach of digital education platforms.

Electricity supply remains an allied challenge. According to UDISE+ 2022-23, approximately 23% of Indian schools experience unreliable power supply, rendering computer laboratories and smart classroom equipment non-functional for significant portions of the school day. Solar-powered school infrastructure grants, piloted in states such as Rajasthan and Uttarakhand, offer a viable model for addressing this constraint.

### 7.2 Teacher Training and ICT Competency

A critical bottleneck in ICT integration is the gap between hardware availability and teacher preparedness. A significant proportion of Indian teachers — particularly in rural government

schools — lack the digital literacy to effectively operate ICT tools, design technology-enhanced lesson plans, or troubleshoot basic hardware and connectivity issues (Kadam, 2020). Surveys indicate that while 61% of urban school teachers report ICT competence, only 32% of their rural counterparts feel confident in using digital tools for classroom instruction (NIEPA, 2022).

Addressing this requires sustained, context-sensitive teacher training — moving beyond one-time workshops toward continuous professional development embedded in teachers' daily practice. The integration of DIKSHA-based training modules into the performance appraisal system of teachers could incentivise uptake and ensure that professional development is ongoing rather than episodic.

### 7.3 Financial Resources and Device Access

Budgetary allocation for ICT infrastructure in schools remains insufficient relative to the scale of the challenge. While the Samagra Shiksha Abhiyan provides composite school grants that include ICT components, ground-level audits reveal that these funds are frequently diverted or underutilised due to inadequate monitoring mechanisms (Chatterjee & Nath, 2015). The proposed 'One Student, One Device' policy framework under NEP 2020 represents an ambitious response but will require substantial fiscal commitment and robust supply-chain infrastructure to be operationalised effectively.

### 8. Future Directions: AI, Emerging Technologies, and the Path Forward

The convergence of Artificial Intelligence (AI), Machine Learning (ML), and Big Data with educational technology represents the next frontier in ICT-enhanced learning. AI-powered tutoring systems can simulate one-to-one instruction, providing personalised feedback, adapting content complexity in real-time, and flagging at-risk learners to teachers before academic difficulties escalate. Countries such as China and the United States have deployed AI tutors at scale; India is at an early stage of this journey but the groundwork is being laid through NEP 2020's explicit recognition of AI literacy as an educational priority.

Augmented Reality (AR) and Virtual Reality (VR) technologies, while currently limited to pilot projects in elite private schools and higher education institutions, hold transformative potential for science education, vocational training, and heritage and culture studies. Virtual laboratories, for instance, allow students in resource-constrained schools to conduct chemistry or physics experiments in safe, immersive digital environments — an innovation particularly valuable in the context of India's chronic shortage of laboratory infrastructure in government schools.

Blockchain technology is being explored as a means of securing educational credentials, reducing certificate fraud, and enabling seamless credit transfer between institutions — issues of particular relevance to India's large and complex higher education ecosystem. The Academic Bank of Credits (ABC), introduced under NEP 2020, relies on digital infrastructure analogous to blockchain principles to allow students to accumulate, store, and transfer academic credits across institutions.

Looking ahead, the sustainability of ICT in Indian education will depend on three interrelated imperatives: equitable access (ensuring that digital tools reach the last-mile learner), pedagogical quality (ensuring that ICT enriches rather than merely replicates traditional instruction), and systemic accountability (ensuring that ICT investments are tracked, evaluated, and scaled based on evidence). Curriculum frameworks such as the Taba Model — which emphasises inductive, evidence-driven curriculum development — and the Lawton Model — which situates curriculum design within broader social and cultural contexts — offer useful theoretical lenses for designing ICT-integrated syllabi that are both pedagogically sound and contextually relevant.

### 9. CONCLUSION

This study has examined the role of ICT in Indian education through multiple analytical lenses — technological infrastructure, government policy, pedagogical practice, learning outcomes, and systemic barriers. The evidence unambiguously affirms that ICT, when deployed thoughtfully and equitably, is a powerful engine of educational transformation. It democratises access to quality content, empowers teachers, enables personalised learning, and aligns Indian education with the demands of a knowledge-driven global economy.

At the same time, the study underscores that technology is not a silver bullet. The gains from ICT integration are contingent on foundational investments in connectivity, electricity, device access, teacher training, and inclusive content development. The rural-urban digital divide and the gender gap in digital access represent the most urgent challenges demanding policy attention. Without deliberate corrective action, the rapid expansion of ICT in education risks deepening rather than closing existing educational inequalities.

India's NEP 2020 provides an ambitious and coherent policy vision for ICT in education. The challenge of the coming decade lies in translating that vision into ground-level reality — ensuring that every child, regardless of geography, gender, language, or socioeconomic background, can benefit from the transformative power of technology-enhanced learning. Achieving this will require sustained political will, coordinated intergovernmental action, private sector partnership, and above all, a commitment to placing the learner at the centre of every technological decision.

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