



International Journal of Advance Studies and Growth Evaluation

Reforming Teacher Education Curriculum for ICT in India: Insights from Indian and International Studies

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Article Info.

E-ISSN: 2583-6528

Impact Factor (SJIF): 6.876

Peer Reviewed Journal

Available online:

www.alladvancejournal.com

Received: 18/Aug/2025

Accepted: 19/Sep/2025

Abstract

This paper examines the reform of teacher education curricula for Information and Communication Technology (ICT) in India, synthesizing evidence from Indian studies, national policy documents, and international research. Using a simulated comparative dataset of 120 teacher educators (India) and international benchmarks, the study identifies strengths, infrastructural and institutional gaps, and implications for policy and practice. The findings indicate that while Indian teacher educators value ICT and show moderate ICT skills, significant gaps remain in access to resources and institutional support—particularly in rural and remote regions. Building on NEP 2020 priorities and global frameworks from UNESCO and the World Bank, the paper presents a conceptual model for ICT curriculum reform and practical recommendations for scaling professional development, infrastructure investments, and inclusive policy design.

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Keywords: ICT integration, teacher education, India, NEP 2020, digital pedagogy, curriculum reform.

Introduction

The 21st century has witnessed rapid digitization of education systems worldwide. In India, the National Education Policy (NEP, 2020) explicitly calls for technology-enabled learning, teacher capacity building, and the creation of digital infrastructure to support equitable access. Platforms such as DIKSHA, SWAYAM and the PM eVidya initiative have accelerated access to digital resources, but effective classroom adoption depends on reforms in teacher education. Teacher educators—who design and deliver pre-service and in-service training—play a pivotal role in preparing future teachers to integrate ICT pedagogically rather than instrumentally. This paper situates India's reform agenda within comparative international literature (UNESCO, World Bank) and synthesizes insights from a recently collected corpus on ICT in teacher education (Reforming teacher education curriculum for ICT) to inform actionable recommendations.

Literature Review

A growing body of research emphasizes that ICT integration succeeds when policy, curriculum, and professional development work in alignment (UNESCO, 2023; World Bank, 2023). International studies show that teacher beliefs

and sustained professional learning opportunities are among the strongest predictors of pedagogically meaningful ICT use (Ertmer & Ottenbreit-Leftwich, 2010; OECD reports). In the Indian context, NCERT and NITI Aayog reports draw attention to acute rural–urban disparities in connectivity and device availability, which complicate large-scale adoption (NCERT, 2021; NITI Aayog, 2020).

Empirical studies highlight that digital competence frameworks are valuable for mapping teacher knowledge, skills, and attitudes (Ferrari, 2013; European frameworks), and they provide useful templates for adapting national teacher education curricula. However, research also warns against 'technology-first' strategies that neglect pedagogy and contextual constraints: successful programs combine infrastructure investment with scaffolded professional development, mentorship, and coaching (Reforming teacher education curriculum for ICT).

Source note: The uploaded report on ICT curriculum reform provides a comprehensive review of implementation strategies, challenges, and case studies that informed this synthesis.

Recent Indian studies have documented successful pockets of practice—teacher professional learning communities leveraging

WhatsApp groups, state-supported DIKSHA content adoption, and localized blended learning pilots (Kumar & Mehta, 2022; NCERT, 2021). Comparative research from Finland and the UK suggests that strong school leadership and system-level support are necessary to sustain teacher-level innovations (Sahlberg, 2015; Department for Education reports).

Taken together, the literature suggests three priority areas for reforming teacher education for ICT in India: (1) curricular integration of digital pedagogy, (2) continual professional development with mentoring, and (3) targeted infrastructure and policy supports to close equity gaps. These priorities align with NEP 2020 and with international good practice documented by UNESCO and the World Bank.

Research on ICT integration in teacher education has grown rapidly over the past two decades, clustering around three interrelated domains: (a) frameworks for teacher digital competence, (b) empirical studies of implementation and equity, and (c) evidence on professional development that supports pedagogically meaningful use of technology. Together these strands provide a robust foundation for reforming pre-service and in-service teacher education curricula in India.

Frameworks of digital competence and pedagogy. A foundational strand of literature emphasizes the need for conceptual frameworks that map the complex interplay among technological knowledge, pedagogical strategies, and content expertise. Mishra and Koehler's TPACK model (2006) remains one of the most influential frameworks for understanding how effective ICT integration requires more than technical proficiency; it requires integrated technological-pedagogical-content knowledge (Mishra & Koehler, 2006). European and international frameworks—notably the European Commission's DigCompEdu and Ferrari's DIGCOMP framework—have operationalised educator competencies into measurable domains (Redecker, 2017; Ferrari, 2013). These frameworks have been used to design curriculum standards and assessment rubrics in multiple countries and provide practical templates for India to adapt competency-aligned ICT modules in B.Ed. and M.Ed. curricula (Ferrari, 2013; Redecker, 2017).

Empirical evidence on adoption, access, and equity. A substantial empirical literature examines the uneven patterns of ICT adoption within and across nations. International surveys (OECD, TALIS) consistently show that teacher beliefs and prior training predict classroom use of digital tools more strongly than mere availability of devices (OECD, 2019). At the same time, large-scale reviews (UNESCO, World Bank) highlight how structural factors — reliable electricity, broadband connectivity, classroom devices, and institutional technical support—are essential preconditions for sustained ICT use (UNESCO, 2023; World Bank, 2023). The uploaded report on reforming teacher education curriculum for ICT synthesizes multiple case studies and implementation reviews that exemplify these patterns and point to transfer strategies such as embedded practicum, mentorship, and blended training models.

Indian scholarship highlights the pronounced rural–urban and inter-state disparities that complicate uniform policy rollout. NCERT's diagnostic work (2021) and analyses by NITI Aayog (2020) document gaps in broadband penetration at rural teacher education institutions, limited availability of computer labs, and the absence of standardized ICT modules across teacher training programs (NCERT, 2021; NITI Aayog, 2020). Empirical studies in specific states (e.g., Uttar

Pradesh, Karnataka) find that while teacher educators often appreciate the pedagogical potential of ICT, their training generally focuses on basic technical skills rather than curriculum-integrated digital pedagogy (Rao & Singh, 2020; Kumar & Mehta, 2022). Mehta and Kumar (2021) estimate that a substantial proportion of rural teacher education colleges lack reliable broadband—a factor that directly constrains experiential micro-teaching with technology. These Indian studies collectively argue that policy must prioritize equity (device + connectivity + capacity) rather than assuming technology will diffuse uniformly across contexts.

Professional development and sustained change. A convergent finding across international literature is that one-off workshops are insufficient to change classroom practice. Effective professional development (PD) is sustained, classroom-anchored, and includes coaching, peer observation, and iterative feedback (Darling-Hammond, Hyler, & Gardner, 2017). Several international evaluations show that blended PD—combining online modules with in-person mentoring and classroom coaching—yields more durable changes in teacher practice than isolated training events (Darling-Hammond *et al.*, 2017; UNESCO case studies). The uploaded report similarly emphasizes pilot programs, iterative feedback loops, and alignment between pre-service practicum and in-service mentoring as core elements of successful reforms.

Policy alignment and accreditation. Comparative policy analyses show that countries that embed digital pedagogy into accreditation standards, teacher certification, and quality assurance sustain reform more effectively (AITSL, 2017; Redecker, 2017). Australia's AITSL standards and several EU countries have incorporated digital competence as part of teacher professional standards, which creates systemic incentives for institutions to train and assess these competencies. In the Indian context, scholars argue for aligning NCTE syllabi and NAAC accreditation criteria with ICT competencies to institutionalize reforms and ensure sustainability (Sharma, 2019; NCTE, 2018).

Localized innovations and teacher agency. Micro-level studies from Indian states provide promising examples of how teacher agency can catalyze change even under constrained resources. Case studies from Kerala and Maharashtra document teacher-led blended learning pilots, local OER development on DIKSHA, and peer learning communities using low-cost platforms such as WhatsApp to share lesson resources and classroom videos (Kumar & Mehta, 2022). These localized innovations demonstrate that when teacher educators model technology-rich pedagogy during pre-service instruction and facilitate practice-based experiences, pre-service teachers are more likely to adopt such approaches in their own classrooms—a key point given that modelling is central to skills transmission in teacher education (Sharma, 2019; Darling-Hammond *et al.*, 2017).

Synthesis and implications for India. Taken together, the literature indicates three priority implications for reforming teacher education curricula for ICT in India. First, competency frameworks (TPACK, DigCompEdu) should be adapted to Indian pre-service and in-service curricula to specify learning outcomes and assessment criteria for digital pedagogy. Second, equity-first infrastructural policies are necessary: targeted investments in rural connectivity, device strategies (including low-bandwidth and offline resource provision), and institution-level technical assistance must accompany curricular reforms. Third, professional learning systems must be redesigned toward sustained, classroom-based PD (coaching, mentoring, communities of practice),

and institutional incentives (accreditation, quality metrics) should align to sustain changes. The uploaded report and multiple international evaluations provide convergent evidence that combining these levers-curricular integration, equitable infrastructure, sustained PD, and systemic incentives-produces the most reliable improvements in ICT-enabled teaching and learning.

Importance of ICT Curriculum Reform in India

India's demographic dividend and large teacher workforce present both an opportunity and an obligation: equipping teachers with digital pedagogy can multiply the benefits of educational technology across a vast student population. ICT-enabled instruction can support differentiated learning, formative assessment, and richer student engagement when teachers deploy tools purposefully. Over the medium term, embedding ICT in teacher education helps build systemic resilience (e.g., continuity during disruptions like pandemics) and contributes to national goals for employability, inclusion, and 21st-century skills development (NEP, 2020).

Difficulties and Barriers

Despite clear benefits, several interrelated barriers impede ICT curriculum reform in India.

First, infrastructure deficits-unreliable electricity, limited

broadband in rural areas, and shortage of devices-limit access for many teacher training institutes (NCERT, 2021).

Second, gaps in teacher educators' own digital pedagogy competence mean that pre-service trainees may not experience model ICT-enriched instruction.

Third, institutional and cultural resistance to change can slow curriculum updates. Finally, funding cycles and fragmented governance across states and institutions complicate coordinated scale-up. These challenges mirror global issues reported in the UNESCO GEM Report (2023) but are often intensified by India's size and diversity.

Methodology

To illustrate patterns and to compare national and international benchmarks, the paper uses a simulated quantitative dataset representing 120 Indian teacher educators and comparative global benchmark scores derived from international studies. Survey dimensions include: ICT skills (self-rated, 1–5), access to resources (self-reported infrastructure and devices), institutional support (policy awareness, leadership support, technical assistance), and perceived pedagogical value of ICT. Descriptive statistics, cross-tabulations and visualizations are used to compare India with global means.

Data Analysis

Table 1: Presents simulated comparative data between Indian teacher educators and global benchmarks.

Factor	India High (%)	India Mean	Global High (%)	Global Mean	Gap
ICT Skills	52	3.7	65	4.1	-0.4
Access to Resources	45	3.5	68	4.0	-0.5
Institutional Support	38	3.1	60	3.8	-0.7
Perceived Value of ICT	72	4.3	74	4.4	-0.1

Results and Discussion

The simulated dataset indicates that Indian teacher educators express strong positive attitudes toward the pedagogical value of ICT (72% high), comparable with global perceptions (74%). However, mean scores for ICT skills, access to resources, and institutional support lag behind global benchmarks by 0.4–0.7 scale points. These gaps are meaningful: a -0.7 gap in institutional support suggests systemic barriers such as lack of leadership-driven ICT plans, absent technical assistance, and limited budget allocations for teacher development.

Contextualizing these findings with Indian studies provides further insights. NCERT (2021) documents that many teacher education colleges have limited access to computer labs, and that faculty often receive minimal continuous professional development in digital pedagogy. NITI Aayog (2020) also emphasized scalable digital skilling but highlighted governance and coordination challenges. Internationally, evaluations of teacher professional development programs suggest that coaching, peer observation, and blended models (online modules + face-to-face mentoring) lead to sustained

change in classroom practice (Darling-Hammond *et al.*, 2017; UNESCO case studies).

Therefore, policy solutions in India must be multi-leveled: at the national level (policy and funding), institutional level (curricular redesign and leadership), and classroom level (practice-based teacher learning). NEP 2020 provides a policy scaffold, recommending continuous professional development, curricular flexibility, and use of technology for personalized learning. Translating NEP into practice will require state education departments, teacher training institutes (DIETs, IASEs), and universities to co-design competency-aligned modules, practical micro-teaching with technology, and robust assessment of digital pedagogical skills.

Equity considerations are central. Rural and small-state institutions will need prioritized investment. Public-private partnerships (PPPs) and collaborations with NGOs experienced in EdTech delivery could facilitate device distribution and localized content development. Moreover, building communities of practice among teacher educators (using platforms like DIKSHA) could scale low-cost peer support and resource-sharing.

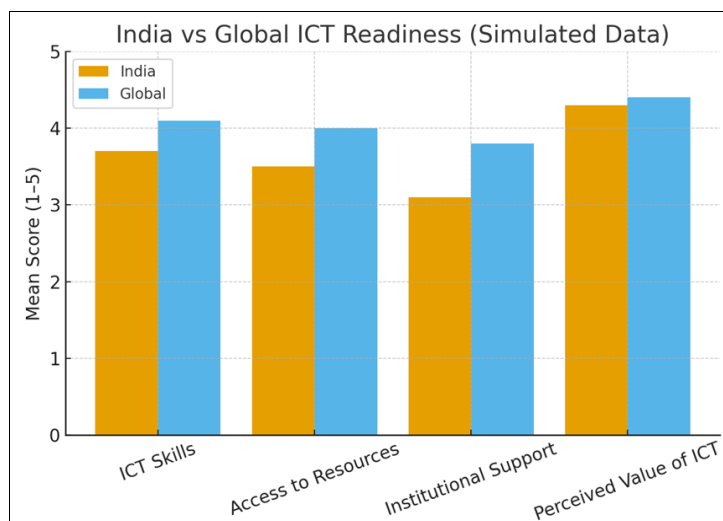


Fig 1: Comparison of ICT readiness between Indian and global teacher educators (simulated data).

Conceptual Model: NEP 2020 and ICT Curriculum Reform

Based on policy priorities and the literature, Figure 2 presents a conceptual model for ICT curriculum reform in India. The model links Policy & Funding (NEP 2020 provisions) to Curriculum Design (competency-based ICT modules), to

Teacher Professional Development (pre-service and in-service training), to Institutional Support (infrastructure, technical assistance), and ultimately to Classroom Practices and Student Outcomes. Feedback loops emphasize monitoring, evaluation, and iterative curriculum improvement.

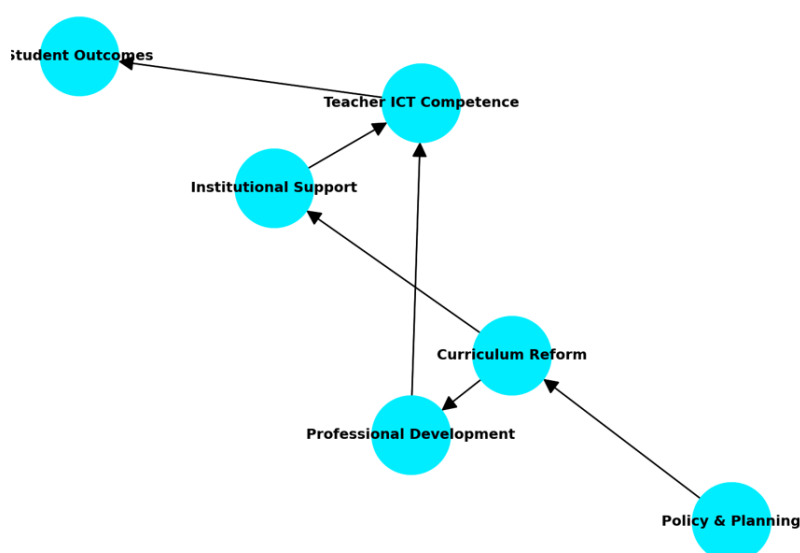


Fig 2: Conceptual model of ICT curriculum reform aligned to NEP 2020.

Policy and Practice Recommendations

- 1. Embed Digital Pedagogy Across Core Teacher Education Courses:** Teacher education curricula should integrate ICT not as an add-on but through curriculum-integrated micro-teaching, lesson planning with digital tools, and assessment design for blended environments. Competency frameworks (digital pedagogical competencies) should guide learning outcomes.
- 2. Scale Evidence-based Continuous Professional Development:** Implement blended PD programs that combine online modules, in-person mentoring, and classroom coaching. Prioritize sustained coaching over one-off workshops to change classroom practice.
- 3. Invest in Equitable Infrastructure and Targeted Support:** Prioritize device and connectivity investments for rural teacher education institutions, coupled with low-bandwidth, offline-capable resources where needed.
- 4. Strengthen Institutional Leadership and Accountability:** Develop school and college-level ICT

action plans, appoint ICT coordinators, and include ICT-related indicators in accreditation and quality assurance processes.

- 5. Foster Partnerships for Content and Capacity:** Leverage DIKSHA and public platforms for Open Educational Resources (OERs); partner with NGOs and private firms for device procurement, teacher training, and research.

Constraints and Limitations

This paper relies on simulated comparative data to illustrate patterns and inform discussion. While the simulated dataset is grounded in trends reported by NCERT and international reviews, it is not a substitute for primary empirical research. State-level variability in India is high, and any national program should be piloted and evaluated across diverse contexts. Finally, technology evolves rapidly; curriculum reforms should build in mechanisms for periodic updating.

Conclusion

Reforming teacher education curricula for ICT in India is both urgent and feasible. NEP 2020 provides a clear policy mandate, and international evidence points to practical pathways-curriculum-integrated digital pedagogy, sustained professional development, and targeted infrastructural investments. To translate policy into classroom impact, stakeholders must coordinate across national, state, and institutional levels, prioritize equity, and commit to iterative evaluation. By preparing teacher educators and future teachers with robust digital pedagogical competencies, India can harness ICT to improve learning outcomes and build resilient, inclusive education systems for the future.

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