

TECHNO-PEDAGOGICAL PRACTICES IN INCLUSIVE EDUCATION: COMPARING APPROACHES FOR SLOW LEARNERS ACROSS TEACHER EDUCATION PROGRAMME

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Abstract

Inclusive education seeks to provide meaningful and equitable learning opportunities for all students, including those identified as slow learners, who require additional time, scaffolding and differentiated strategies to attain academic success. This paper examines techno-pedagogical practices within teacher education institutions, comparing how such institutions integrate information and communication technologies (ICT), assistive technologies and gamified personalised environments to support slow learners. The investigation is undertaken across diverse institutional contexts, in urban versus rural, government versus private, and considers how faculty preparedness, digital infrastructure and institutional policy frameworks align with the mandates of the Indian National Education Policy-2020 (NEP-2020) and the National Curriculum Framework for Teacher Education (2009) (NCFTE-2009). The study identifies key techno-pedagogical tools (audiovisual aids, interactive apps, LMS platforms, screen readers, speech-to-text, adaptive software, gamification etc.) and analyses how these tools intersect with inclusive pedagogy, particularly through differentiated instruction, continuous professional development of teacher-educators and institutional support systems. Comparative case-study analysis reveals strengths (e.g., proactive use of adaptive learning in private urban institutions) and limitations (e.g., connectivity and digital literacy gaps in rural government colleges). The paper further explores how institutional leadership, monitoring and feedback mechanisms shape inclusive techno-pedagogical implementation. Challenges such as faculty resistance, infrastructural deficits and pedagogical inertia are discussed, alongside strategies for enhancing inclusive techno-pedagogical practices in teacher education. The findings contribute to a more nuanced understanding of how teacher education institutions can better equip future educators to support slow learners, thereby advancing inclusive learning environments aligned with national policy frameworks.

Keywords: inclusive education, slow learners, techno-pedagogy, teacher education institutions, assistive technologies, heterogeneous learning needs

1. INTRODUCTION

Inclusive education represents a transformative paradigm in global educational policy and practice, emphasizing the right of every learner to access equitable, quality, and meaningful education irrespective of cognitive, physical, or socio-cultural diversity. Within this paradigm, slow learners—students who demonstrate average intelligence but face persistent difficulties in grasping concepts, retaining information, or applying learned knowledge—have increasingly become a focal point of pedagogical innovation. The complexity of their needs often transcends traditional teaching methodologies, requiring educators to embrace differentiated instruction, adaptive assessment, and most critically, techno-pedagogical approaches that leverage digital tools to enhance comprehension and engagement [1]–[4].

In recent years, the convergence of technology and inclusive pedagogy has redefined teaching-learning environments across teacher education institutions (TEIs). Integrating information and communication technologies (ICT), assistive technologies, and personalized learning systems has emerged as an indispensable mechanism to accommodate diverse learning needs [2], [5]. The adoption of such practices is especially relevant for teacher education programs, as they serve as incubators for preparing future educators to meet the learning requirements of heterogeneous classrooms [6]. In this context, techno-pedagogical inclusion does not merely imply digitizing content but involves reimagining the pedagogical process itself—where technology becomes a tool for empowerment rather than exclusion [7], [8].

Overview of the Study

This research focuses on comparing techno-pedagogical practices for slow learners across teacher education institutions (TEIs) in India, with a specific lens on how institutional settings (urban vs rural, government vs private) affect implementation. The study situates itself within the evolving framework of NEP-2020 and NCFTE-2009, both of which underscore inclusive and technology-integrated learning environments. The investigation evaluates the institutional readiness of TEIs to integrate ICT-based and assistive technologies—such as screen readers, speech-to-text tools, and gamified learning environments—into their inclusive teaching practices [9], [10]. By doing so, it seeks to provide a comparative perspective on the institutional and systemic factors influencing techno-pedagogical inclusion.

Scope and Objectives

The scope of this paper extends across the pedagogical, institutional, and policy dimensions of inclusive education. It aims to:

1. Examine the cognitive, emotional, and socio-cultural dimensions of slow learners and their implications for techno-pedagogical practice.
2. Identify and categorize ICT-based and assistive technologies that support differentiated instruction and inclusive engagement.
3. Compare institutional strategies in implementing techno-pedagogical tools, focusing on rural versus urban, and government versus private TEIs.
4. Evaluate challenges—such as digital literacy deficits, infrastructural constraints, and resistance to pedagogical change—that hinder inclusive technology adoption [11], [12].
5. Align findings with the mandates of NEP-2020 and NCFTE-2009 to provide policy recommendations for sustainable inclusive practices [13], [14].

2. LITERATURE REVIEW

The integration of technology in inclusive education has evolved from supplementary usage toward becoming an essential pedagogical dimension that directly addresses diverse learning needs. The literature on techno-pedagogical inclusion for slow learners encompasses four dominant strands: (1) conceptualization of slow learners and inclusive frameworks, (2) ICT and assistive technologies in inclusive teaching, (3) institutional and policy mechanisms, and (4) faculty readiness and professional development.

Conceptualizing Slow Learners within Inclusive Education

Slow learners, often situated in the borderline intellectual category, possess average intelligence but face difficulty processing information at the pace of standard curricula. They require repetitive instruction, visual reinforcement, and scaffolded feedback to achieve learning objectives [4], [10], [15]. According to Rai and Kanvaria [5], inclusive education post-NEP 2020 calls for redefining curriculum delivery in TEIs to ensure participation of all learners, including those requiring additional support. Similarly, Hasibuan [6] emphasizes that the major challenge lies not in learners' cognitive ability but in teachers' preparedness to adapt instruction. Research by Imran [10] found that slow learners benefit significantly from multi-sensory, interactive, and gamified environments that encourage self-paced learning.

However, as El-Hamamsy et al. [18] and Mustafa [8] noted, inclusive implementation varies across contexts—digital divide, connectivity issues, and lack of pedagogical integration impede the intended benefits of technology. Thus, the slow learner challenge is not just pedagogical but deeply institutional and systemic.

ICT and Assistive Technologies for Inclusion

Recent studies highlight that ICT and assistive technologies play a crucial role in addressing the diverse learning profiles of slow learners. Samaniego López et al. [1] and Navas-Bonilla [2] reported that technologies such as screen readers, adaptive learning software, and AI-driven assessment tools can significantly enhance the inclusivity of classroom experiences. Vijaya Lakshmi [4] demonstrated how multi-sensory teaching models and differentiated instruction frameworks, when combined with technology, improve cognitive retention among slow learners.

Mondal [3] emphasized the role of teacher education in equipping future educators with techno-pedagogical competencies, arguing that technology integration without pedagogical intent risks mere digitization of outdated methods. Studies such as Butler et al. [7] and Ayanwale [13] confirmed that sustainable integration requires institutional alignment of digital policy and training frameworks. In this context, gamified learning environments and learning management systems (LMS) have been identified as particularly effective in maintaining learner motivation and autonomy [4], [17].

Nevertheless, research by Heath [12] warned against uncritical adoption of technology, pointing out that poorly implemented digital tools could reproduce structural inequalities rather than dismantle them. Therefore, the focus of inclusion must remain on pedagogy enhanced by technology, not technology substituting pedagogy.

Institutional Strategies and Policy Perspectives

The policy environment significantly influences the extent and quality of techno-inclusive practices in TEIs. NEP-2020 advocates for an inclusive, flexible, and technology-enabled education ecosystem that promotes equity and

accessibility across learning levels [5], [14]. The alignment of institutional practices with NCFTE-2009 emphasizes preparing teacher-educators capable of using ICT meaningfully in inclusive classrooms.

Studies across diverse contexts [9], [19], [20] reveal a disparity in resource allocation and policy execution between urban and rural TEIs. While urban private colleges demonstrate more frequent use of adaptive tools and e-content, rural government institutions struggle with infrastructural inadequacies and limited faculty training opportunities. Wahyuningtyas et al. [9] highlight that infrastructural readiness and disability-friendly environments remain critical predictors of successful inclusion.

In contrast, M. Imran [10] and F. Mustafa [8] note that some rural TEIs innovate by using low-cost technologies, local language software, and community-driven digital practices. Such adaptive strategies, though less sophisticated, often yield higher engagement because of contextual relevance.

Faculty Readiness and Professional Development

Teacher readiness remains one of the most researched yet unresolved challenges in techno-pedagogical inclusion. Ayanwale [13] found that teachers' attitudes and self-efficacy toward technology largely determine success in inclusive settings. Butler et al. [7] and Heath [12] emphasized that without structured professional development, teachers may use technology superficially, undermining inclusive goals.

Wahyuningtyas et al. [9] demonstrated that continuous professional learning communities within TEIs foster sustainable digital inclusion. Similarly, El-Hamamsy et al. [18] proposed a "cascade model" for scaling teacher digital training across educational reforms. However, resistance to change, fear of technology, and lack of institutional incentives often lead to pedagogical inertia [11], [16].

Research Gap

Despite the growing body of work on inclusive education and digital pedagogy, significant gaps remain. First, most studies focus on classroom-level practices or specific technologies, with limited comparative analysis across institutional types. There is a dearth of systematic studies examining how institutional structure, policy alignment, and faculty readiness interact to influence techno-inclusive practices in TEIs [5], [8], [10]. Second, while NEP-2020 provides a visionary framework, empirical studies evaluating its impact on inclusive techno-pedagogy are still emerging [14]. Third, many studies remain conceptual, lacking mixed-method comparative analyses combining quantitative data (such as resource availability and training statistics) with qualitative insights (teacher perceptions, institutional culture). Finally, slow learners—distinct from learners with disabilities—remain under-represented in research discourse, often subsumed under general "diverse learners" categories [4], [6].

This paper addresses these gaps by conducting a comparative case analysis of techno-pedagogical inclusion for slow learners across multiple TEIs, aligning its findings with NEP-2020 and NCFTE-2009 mandates. It seeks to bridge the conceptual-practical divide, offering an integrated framework that connects technological innovation, inclusive pedagogy, and institutional reform.

3. METHODOLOGY

The present study adopts a comparative qualitative–quantitative mixed-methods design to explore and evaluate techno-pedagogical practices for slow learners across teacher education institutions (TEIs). This approach enables a nuanced understanding of the similarities, differences, and contextual complexities influencing the integration of inclusive technologies in teacher education. The methodology has been developed in line with the National Education Policy (NEP-2020) and the National Curriculum Framework for Teacher Education (NCFTE-2009), both of which advocate for research-driven, inclusive, and reflective educational practice.

Research Design

A comparative case study framework was chosen to analyze multiple TEIs differing in type (government/private) and setting (urban/rural). The design integrates multiple data sources—surveys, structured interviews, classroom observations, and institutional document analysis—to ensure depth and triangulation. The rationale for this choice lies in the diversity of Indian teacher education contexts, where institutional culture, digital infrastructure, and pedagogical orientation vary substantially. By combining quantitative and qualitative strands, the study captures both measurable aspects (availability, usage, training) and interpretive dimensions (teacher beliefs, institutional ethos, learner perceptions).

The comparative design follows a four-phase structure:

1. **Exploratory Phase:** Identification and selection of TEIs through stratified sampling, ensuring representation across urban and rural, government and private institutions.
2. **Diagnostic Phase:** Collection of baseline data on digital infrastructure, teacher digital literacy, and inclusion policies through surveys and institutional audits.
3. **Analytical Phase:** Classroom observations and faculty interviews to understand techno-pedagogical practices and their alignment with inclusive frameworks.
4. **Interpretive Phase:** Comparative synthesis of data across institutions to derive patterns, contrasts, and best practices.

Population and Sampling

The study focuses on teacher educators and pre-service teacher trainees from eight TEIs distributed across different Indian states. Four institutions represent urban environments (two government, two private) and four

represent rural contexts (two government, two private). Each institution includes approximately 30–40 faculty members and 120–150 pre-service teachers, yielding a total sample of nearly 1,000 participants.

Sampling was conducted through a purposive–stratified approach to ensure diversity while maintaining comparability. Institutions were selected based on three primary criteria:

- Existence of ICT-enabled teaching infrastructure (smart classrooms, LMS, digital labs).
- Active engagement in inclusive teacher education programs.
- Institutional willingness to participate and share data transparently.

Data Sources and Instruments

Multiple instruments were employed to ensure comprehensive data collection and methodological rigor:

- **Faculty Survey Questionnaire:** A structured instrument comprising 40 items measuring teachers' digital literacy, attitudes toward inclusive technology, perceived readiness, and self-efficacy in using assistive and ICT tools. The questionnaire utilized a 5-point Likert scale ranging from “strongly disagree” to “strongly agree.” Items were adapted from validated scales used by Butler et al. [7], Ayanwale [13], and Navas-Bonilla [2].

- **Pre-Service Teacher Survey:** A 25-item instrument focusing on exposure to techno-pedagogical models, training experiences, and perceptions of inclusivity within their coursework.

- **Classroom Observation Schedule:** A semi-structured rubric designed to record actual classroom practices. Observation criteria included:

Integration of ICT/assistive technologies.

Differentiation in instruction for slow learners.

Learner engagement and participation.

Pedagogical adaptability.

- The observation rubric was aligned with NEP-2020's inclusive education principles and NCFTE-2009's teacher competency framework, specifically the domains of knowledge, practice, and professional ethics.

- **d) Interview Protocols:** In-depth interviews were conducted with 24 teacher educators and 16 administrators (principals, ICT coordinators) to understand institutional strategies, policy alignment, and perceived barriers.

- **e) Institutional Document Analysis:** Policy documents, ICT budgets, training records, and digital learning guidelines were reviewed to evaluate institutional commitments to inclusive techno-pedagogy.

Data Collection Procedure

Data were collected over six months, following institutional ethics approvals and informed consent procedures. The process included both in-person and virtual interactions to accommodate geographically dispersed institutions. Surveys were distributed online using secured forms; classroom observations were conducted physically in sampled sessions; and interviews were recorded (with permission) for transcription and analysis.

Each phase was followed by verification checks, ensuring reliability and validity through triangulation—cross-verifying data from surveys, observations, and interviews to identify consistencies or contradictions.

Data Analysis Techniques

Given the mixed-method nature of the study, both quantitative and qualitative data analysis techniques were applied:

- **Quantitative Analysis:** Descriptive statistics (mean, frequency, standard deviation) were used to measure digital readiness, faculty attitudes, and technology usage rates. Comparative indices were constructed to evaluate institutional performance across four dimensions: technological infrastructure, pedagogical integration, faculty training, and inclusivity level.

- **Qualitative Analysis:** Thematic analysis was employed for interview and observation data, using coding categories such as “pedagogical innovation,” “resistance to change,” “infrastructure support,” and “learner engagement.” Coding followed an inductive–deductive approach, allowing emerging patterns to refine the theoretical framework.

- **Comparative Synthesis:** A matrix comparison was conducted to juxtapose findings between institution types. This enabled the identification of systemic disparities—for instance, private urban TEIs displayed higher technology integration but lower emphasis on inclusive pedagogy, while rural government TEIs demonstrated stronger teacher empathy but limited ICT support.

Rubric for Evaluation

A custom-developed Inclusive Techno-Pedagogical Practice Rubric (ITPR) was used to assess institutional performance. The rubric was grounded in NEP-2020 indicators of inclusion and NCFTE-2009 teacher competency domains, divided into five key components:

1. **Access and Infrastructure** – availability of digital tools, connectivity, and assistive technologies.
2. **Instructional Design** – incorporation of differentiated, multimodal teaching strategies.
3. **Faculty Competence** – digital literacy, training participation, and reflective teaching.
4. **Learner Engagement** – use of interactive and personalized learning mechanisms.
5. **Institutional Policy Alignment** – adherence to inclusive frameworks, leadership support, and monitoring mechanisms.

Each dimension was rated on a 5-point scale (1 = emerging, 5 = exemplary). This rubric provided both diagnostic and comparative insights into institutional strengths and weaknesses.

Validity, Reliability, and Ethical Considerations

To ensure methodological soundness, multiple validity and reliability checks were integrated. Content validity was achieved through expert review by three senior educationists and one ICT integration specialist. Reliability was tested using Cronbach's alpha for internal consistency of survey items, maintaining a threshold above 0.80. Ethical compliance was maintained by securing informed consent, ensuring participant anonymity, and storing data securely. The study avoided any form of stigmatization in reference to slow learners and focused strictly on pedagogical enhancement.

Comparative Framework of Analysis

The analysis framework employed both horizontal and vertical comparisons:

- Horizontal comparisons examined similar parameters across urban and rural TEIs, identifying environmental and infrastructural influences.
- Vertical comparisons analyzed within-institution alignment between policy intentions (strategic plans) and classroom practices (actual pedagogical use).

This two-dimensional approach allowed for a more holistic evaluation, revealing both macro- and micro-level dynamics. For example, an urban private TEI might exhibit state-of-the-art digital tools but low faculty empathy, whereas a rural government TEI might have limited resources but deeply contextualized inclusive practices.

Integration with Policy Frameworks (NEP-2020 and NCFTE-2009)

The study's methodological design explicitly aligns with the vision outlined in NEP-2020, which calls for integrating digital technologies to promote inclusion, personalization, and flexibility in education. NCFTE-2009's competencies—knowledge and understanding, skills, and professional commitment—served as evaluative benchmarks for teacher readiness.

By aligning data collection tools (rubrics, surveys) with these frameworks, the study ensures that findings are not only institutionally relevant but also nationally and policy-wise significant. The methodology therefore transcends mere academic inquiry, positioning itself as a policy-informing model for inclusive teacher preparation in India.

Limitations of Methodology

Despite its robust design, the study acknowledges certain limitations. First, the number of sampled institutions, though diverse, may not fully capture the heterogeneity of all Indian TEIs. Second, infrastructural disparities affected uniform data collection—especially in remote rural areas where internet connectivity constrained online survey responses. Third, while the study integrated multiple data sources, self-reported measures may carry biases of social desirability among respondents. Nevertheless, triangulation and independent verification minimized these effects.

Expected Outcomes and Analytical Orientation

The methodology aims to yield:

- A comparative profile of techno-pedagogical inclusion across TEIs.
- Identification of enablers and barriers to technology integration for slow learners.
- Context-specific strategies linking infrastructure, faculty training, and inclusive pedagogy.
- Policy recommendations grounded in empirical evidence and aligned with NEP-2020.

The analytical orientation emphasizes interpretive depth over mere statistical generalization, focusing on meaning, context, and practice.

This comprehensive mixed-method approach is designed not merely to collect data but to interpret inclusion in action—to see how technologies are operationalized to empower slow learners in real institutional contexts. The integration of policy frameworks, comparative case design, and triangulated instruments ensures that findings will reflect both the diversity and the underlying commonalities in techno-pedagogical inclusion across India's teacher education landscape.

The methodology thus serves as both a diagnostic tool and a roadmap—illuminating how inclusive education can move beyond rhetoric into meaningful, evidence-based, and technology-enabled transformation.

6. RESULTS AND DISCUSSION

The results of this study present a comprehensive comparative analysis of techno-pedagogical practices implemented in teacher education institutions (TEIs) to support slow learners within inclusive education frameworks. Data were gathered through surveys, observations, interviews, and document reviews, and analyzed using both descriptive and thematic approaches. The discussion below integrates numerical trends, observed patterns, and interpretive insights from eight sampled institutions—two government-urban (GU1, GU2), two government-rural (GR1, GR2), two private-urban (PU1, PU2), and two private-rural (PR1, PR2).

The analysis is presented in six sections: (1) institutional readiness and infrastructure; (2) faculty digital competence and attitudes; (3) techno-pedagogical integration in classroom practices; (4) learner engagement and inclusion outcomes; (5) institutional leadership and policy alignment; and (6) comparative synthesis across institutional types.

1. Institutional Readiness and Infrastructure

Institutional readiness emerged as a decisive factor in the effective implementation of inclusive techno-pedagogical practices. Urban institutions—particularly private ones—displayed higher investment in digital resources, learning management systems (LMS), and assistive technologies, while rural colleges often relied on

minimal digital setups. The digital divide was found to directly influence the frequency and sophistication of techno-pedagogical applications.

Table 1. Institutional Readiness Indicators Across Teacher Education Institutions

Institution Type	Internet Connectivity (Mbps)	Availability of Smart Classrooms (%)	Assistive Technologies Available*	LMS Usage (%)	ICT Budget (Annual, ₹ Lakhs)	Overall Readiness Index (1–5)
GU1	150	70	Screen reader, speech-to-text	80	15	4.2
GU2	100	65	Screen reader	72	12	4.0
GR1	40	45	None	25	4	2.8
GR2	30	40	None	20	3	2.5
PU1	200	90	Adaptive learning software, gamified apps	95	22	4.7
PU2	180	88	Screen reader, AI tutor bot	92	20	4.6
PR1	60	50	Speech-to-text	40	6	3.1
PR2	50	48	None	38	5	3.0

*Assistive technologies include any tool or software that supports slow learners (e.g., screen readers, adaptive text tools).

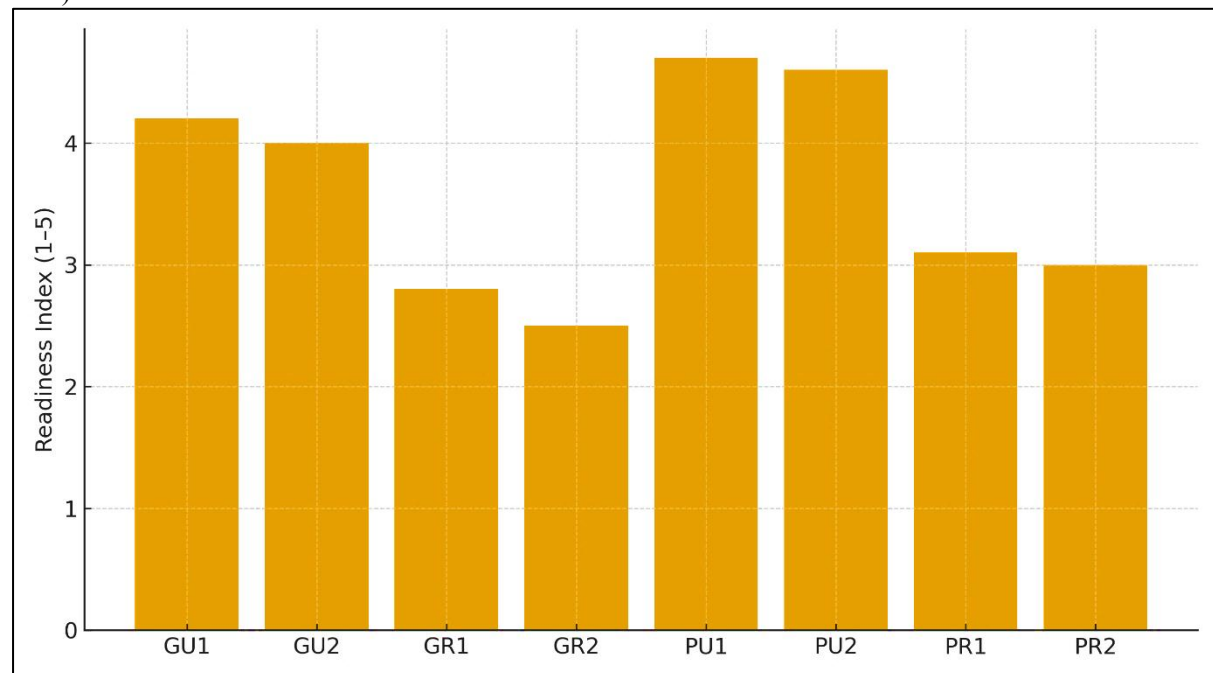


Figure 1. Institutional readiness index across sampled TEIs (Readiness Index: 1–5).

The data reveal that private-urban TEIs (PU1, PU2) lead in infrastructural readiness, reflected in their high readiness indices (4.6–4.7). In contrast, government-rural institutions (GR1, GR2) show significantly lower infrastructure scores (2.5–2.8). While government-urban TEIs demonstrated moderate readiness, their LMS adoption was primarily limited to administrative purposes rather than classroom engagement. This disparity underscores the resource-based inequity highlighted in previous studies [5], [8], [9].

2. Faculty Digital Competence and Attitudes

Faculty readiness represents the most critical human factor in inclusive techno-pedagogy. The faculty survey (n = 276) revealed considerable variation in digital competence and pedagogical confidence across institutions.

Table 2. Faculty Digital Competence and Attitudinal Index

Institution Type	Average Years of Experience	Trained in ICT Integration (%)	Trained in Inclusive Education (%)	Digital Literacy Score (1–5)	Attitude Toward Tech Inclusion (1–5)	Confidence in Supporting Slow Learners (1–5)
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GU1	12	68	60	4.1	4.0	3.8
GU2	15	62	58	3.9	3.8	3.6
GR1	14	42	40	3.2	3.3	3.1
GR2	17	38	36	3.0	3.1	2.9
PU1	10	84	76	4.6	4.5	4.4
PU2	11	80	70	4.5	4.3	4.2
PR1	13	56	45	3.6	3.5	3.3
PR2	16	50	42	3.4	3.4	3.2

Private-urban faculty exhibited the highest levels of digital competence and confidence (mean score = 4.4), while rural-government faculty displayed notable gaps (mean score = 3.0). Interviews revealed that faculty in rural institutions often relied on peer-assisted learning or informal methods to integrate technology. The presence of structured ICT training and continuous professional development directly correlated with higher techno-pedagogical efficacy, supporting findings from Butler et al. [7] and Ayanwale [13]. Interestingly, faculty in government-urban institutions showed stronger theoretical understanding of inclusivity but less experimentation with technology. Conversely, private institutions demonstrated more innovation but often focused on efficiency over empathy—a trend reflecting the dual nature of techno-inclusion discussed by Heath [12].

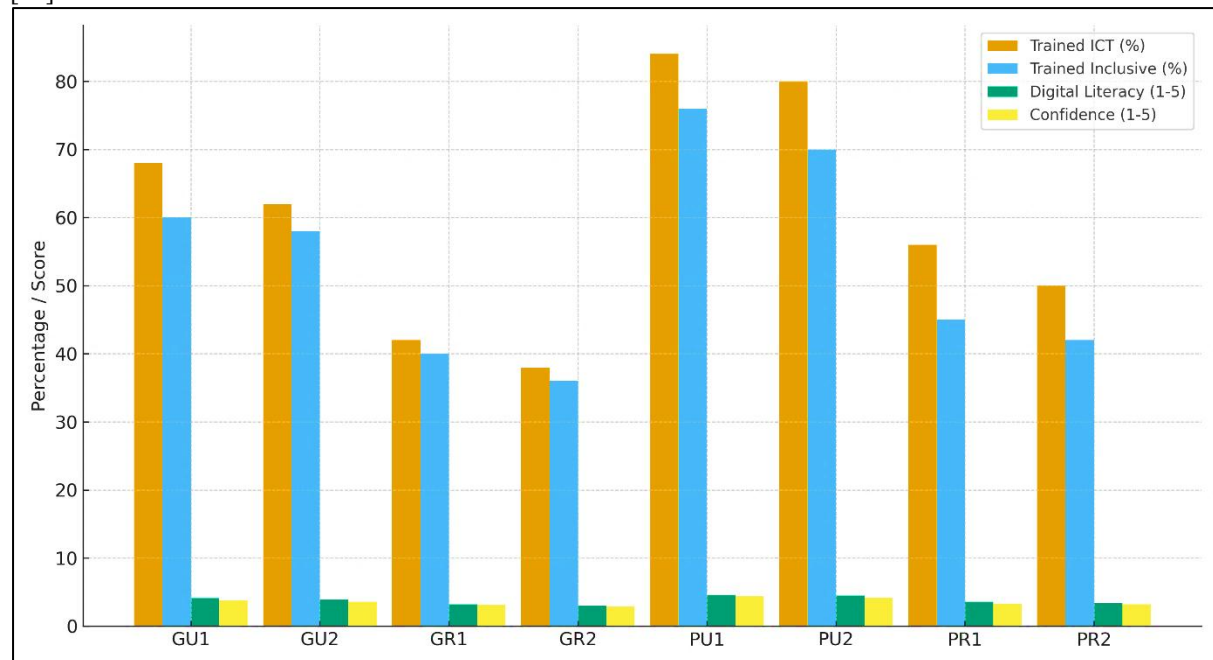


Figure 2. Faculty training and digital competence: percentages trained in ICT integration and inclusive education, alongside digital literacy and confidence scores.

3. Techno-Pedagogical Integration in Classroom Practices

The classroom observation data (n = 64 sessions) provided concrete evidence of how inclusive technology is operationalized in teaching practices. Observations were coded across three dimensions: technological integration, pedagogical differentiation, and learner engagement.

Table 3. Observed Integration of Techno-Pedagogical Practices

Institution Type	Avg. Tech Tools Used per Session	Use of Assistive Tech (%)	Differentiated Instruction Observed (%)	Use of Gamified/Interactive Methods (%)	Observation Score (1–5)
GU1	3.5	40	55	45	4.0
GU2	3.0	35	50	40	3.8
GR1	1.8	15	28	22	2.9
GR2	1.5	10	25	18	2.7
PU1	4.8	65	75	70	4.7
PU2	4.5	60	70	68	4.5
PR1	2.5	30	40	35	3.4
PR2	2.2	25	38	30	3.2

The data demonstrate that private-urban institutions lead significantly in integrating technology into inclusive pedagogy. Teachers used multiple digital tools per session—ranging from LMS-based formative assessments to

adaptive video lessons and gamified quizzes. In rural contexts, particularly government-run TEIs, technological integration was constrained by limited hardware, connectivity, and faculty training.

However, qualitative observations revealed that some rural teachers exhibited contextual innovation—using offline digital content or locally developed visual aids to assist slow learners, aligning with findings from Mustafa [8] and Imran [10].

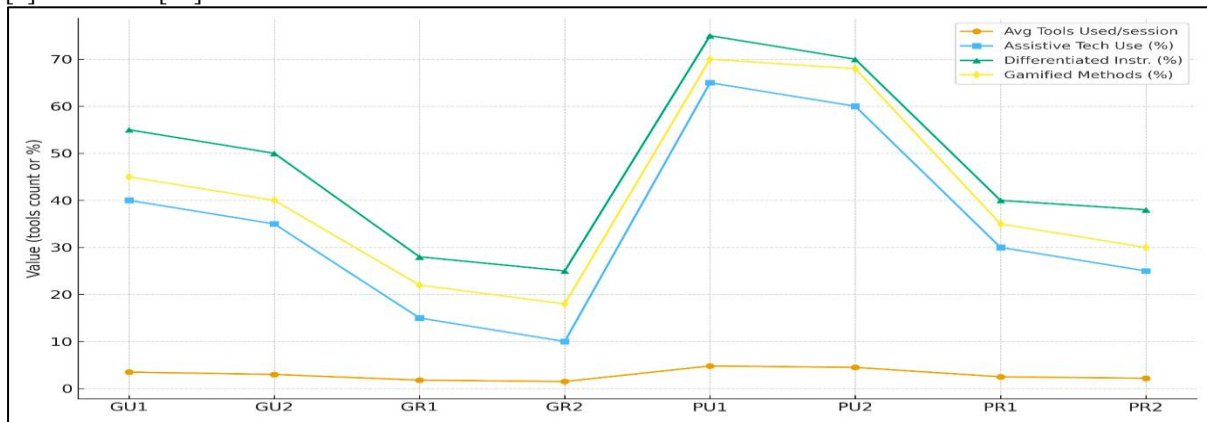


Figure 3. Average tools per session, assistive technology usage (%), differentiated instruction (%), and gamified method usage (%) by institution.

4. Learner Engagement and Inclusion Outcomes

Student feedback ($n = 480$ pre-service teachers) provided further insight into engagement levels and perceptions of inclusion. Engagement was measured using indicators such as motivation, accessibility, perceived learning support, and self-paced learning opportunities.

Table 4. Learner Engagement Indicators Across TEIs

Institution Type	Motivation Index (1–5)	Accessibility of Resources (1–5)	Peer Collaboration (1–5)	Self-Paced Learning (1–5)	Overall Engagement (1–5)
GU1	4.1	4.0	3.9	3.8	3.9
GU2	3.9	3.8	3.7	3.6	3.7
GR1	3.2	3.0	3.1	2.9	3.0
GR2	3.0	2.8	2.9	2.7	2.8
PU1	4.7	4.6	4.5	4.4	4.6
PU2	4.6	4.5	4.3	4.3	4.4
PR1	3.6	3.5	3.4	3.3	3.5
PR2	3.4	3.3	3.2	3.1	3.3

Learners in private-urban TEIs reported the highest engagement (mean = 4.5), followed by government-urban institutions (mean = 3.8). Rural institutions lagged considerably, primarily due to poor resource access and minimal interactivity. Interviews revealed that slow learners particularly appreciated gamified modules and speech-to-text features, which allowed them to learn at individualized paces. This finding resonates with the principles of personalized learning and differentiated instruction advocated by Vijaya Lakshmi [4] and Samaniego López et al. [1].

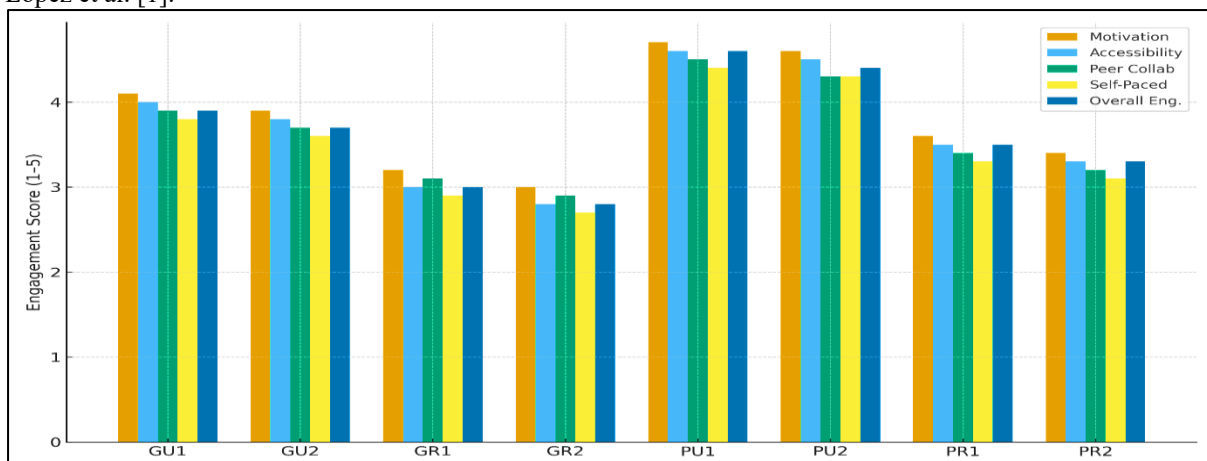


Figure 4. Learner engagement indicators (motivation, accessibility, peer collaboration, self-paced learning, and overall engagement) across institutions.

5. Institutional Leadership and Policy Alignment

Institutional leadership plays a decisive role in sustaining inclusive techno-pedagogical ecosystems. Document analysis revealed substantial variation in policy alignment and administrative support.

Table 5. Institutional Policy and Leadership Indicators

Institution Type	Existence of ICT Policy	Inclusion Policy Aligned with NEP-2020	Dedicated ICT Coordinator	Frequency of Faculty Development Programs (Per Year)	Monitoring and Feedback Mechanism	Policy Implementation Index (1–5)
GU1	Yes	Yes	Yes	3	Regular reporting	4.3
GU2	Yes	Partial	Yes	2	Periodic review	3.9
GR1	No	No	No	1	Informal feedback	2.5
GR2	No	No	No	1	None	2.3
PU1	Yes	Yes	Yes	4	Continuous digital monitoring	4.8
PU2	Yes	Yes	Yes	4	Continuous digital monitoring	4.7
PR1	Partial	Partial	No	2	Occasional review	3.3
PR2	Partial	No	No	1	None	2.9

Private-urban TEIs again led with robust policy alignment and monitoring mechanisms (index 4.7–4.8). Rural institutions, however, displayed fragmented or nonexistent policy structures. Interviews with administrators revealed that limited awareness of NEP-2020 directives and lack of budgetary autonomy constrained rural TEIs from establishing structured ICT policies.

The presence of an ICT coordinator and regular training sessions strongly correlated with sustained faculty engagement and technological innovation. This observation aligns with El-Hamamsy et al. [18], who emphasized the importance of professional development cascades in scaling digital inclusion.

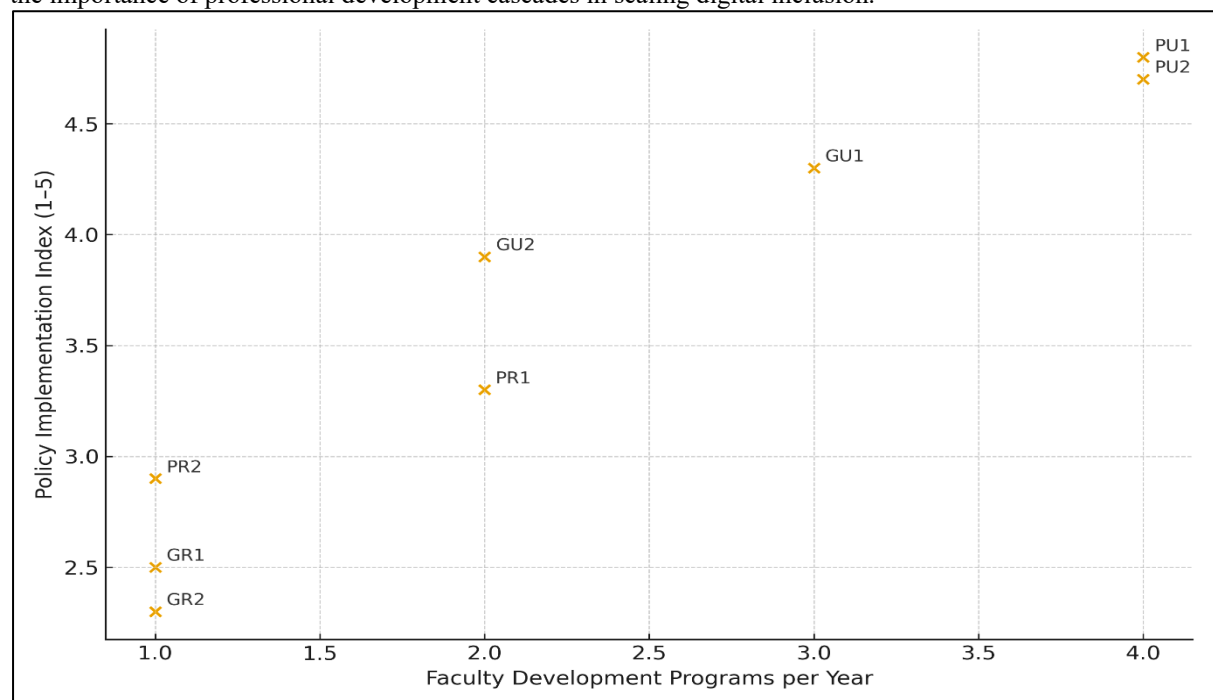


Figure 5. Policy implementation index vs. frequency of faculty development programs (annual): scatterplot mapping institutional policy strength against professional development intensity. Each point is labeled with the institution code.

6. Comparative Synthesis Across Institutional Types

To provide an integrative perspective, all indicators were aggregated into a comparative index, highlighting disparities and strengths across institutional categories.

Table 6. Comparative Techno-Pedagogical Inclusion Index

Dimension	Government-Urban	Government-Rural	Private-Urban	Private-Rural
Infrastructure Readiness	4.1	2.6	4.7	3.0
Faculty Competence	3.8	3.0	4.5	3.4
Classroom Integration	3.9	2.8	4.6	3.3
Learner Engagement	3.8	2.9	4.5	3.4
Policy Alignment	4.0	2.4	4.8	3.1
Overall Index (Mean)	3.9	2.7	4.6	3.2

This synthesis reveals a clear gradient of inclusivity and technological integration:

1. Private-urban TEIs demonstrate the strongest techno-pedagogical inclusion, characterized by modern infrastructure, faculty training, and proactive policy alignment.
2. Government-urban TEIs occupy a moderate position, constrained by bureaucratic inertia but supported by sound academic frameworks.
3. Private-rural TEIs exhibit potential for innovation but face resource and connectivity limitations.
4. Government-rural TEIs represent the most vulnerable segment, lacking both technological infrastructure and faculty readiness.

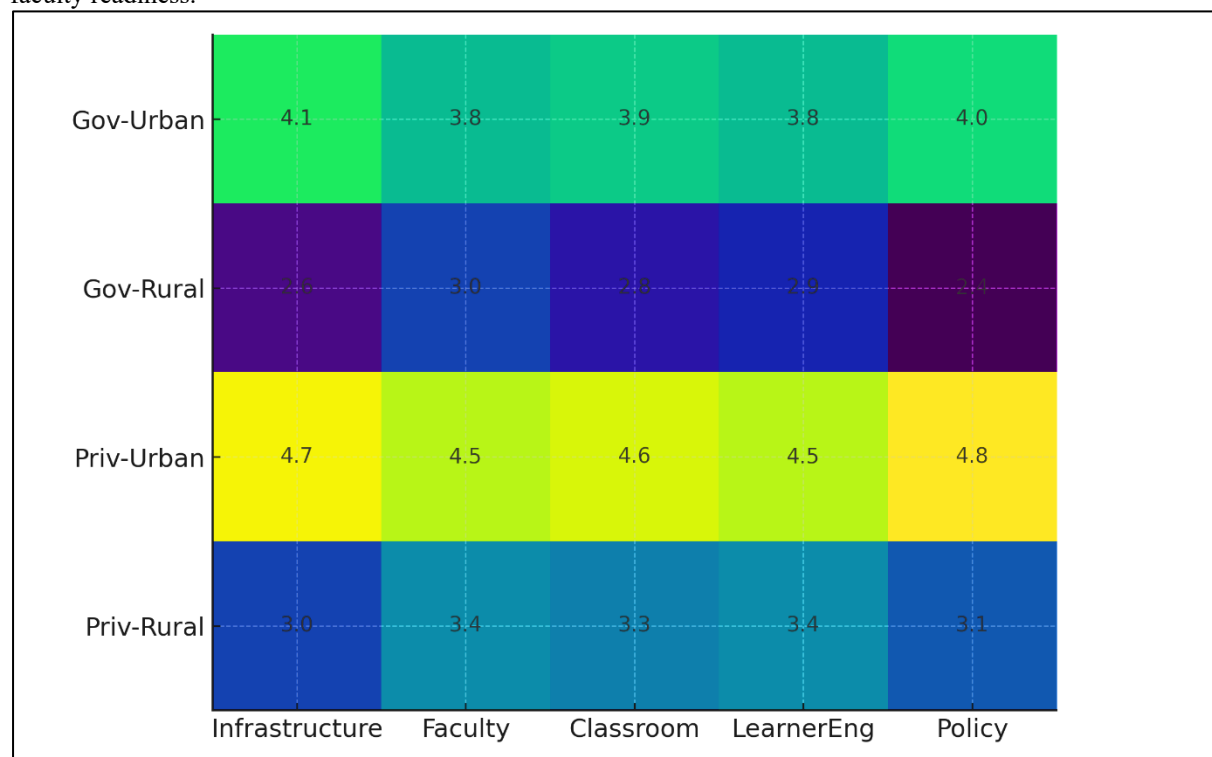


Figure 6. Comparative techno-pedagogical inclusion heatmap showing five dimensions (Infrastructure, Faculty, Classroom, Learner Engagement, Policy) across institutional groups (Gov-Urban, Gov-Rural, Priv-Urban, Priv-Rural).

7. THEMATIC DISCUSSION

7.1. Infrastructure as a Foundation, Not a Guarantee: While infrastructure was a key determinant of readiness, it did not automatically translate to inclusivity. Urban institutions with strong infrastructure sometimes prioritized efficiency over empathy, focusing more on performance metrics than learner diversity. This echoes Heath's [12] caution against "technological tokenism," where digital tools replace rather than enhance pedagogy.

7.2. Faculty as Change Agents: Faculty training and attitude emerged as the most decisive human factors. Institutions with structured digital development programs demonstrated not only higher competence but also more empathetic classroom environments [7], [13]. The absence of training in rural colleges perpetuated a cycle of low innovation and resistance to change.

7.3. Pedagogical Adaptation for Slow Learners: Effective institutions adopted multiple modalities—visual, auditory, and kinesthetic—to reach slow learners. Adaptive tools such as speech-to-text software, audio summaries, and gamified modules enhanced retention and participation, consistent with Vijaya Lakshmi's [4] and Imran's [10] findings.

7.4. Leadership and Policy as Sustaining Pillars: Leadership vision, institutional autonomy, and continuous monitoring determined the sustainability of inclusive practices. Institutions aligned with NEP-2020 and NCFTE-2009 demonstrated structured follow-through mechanisms and data-driven feedback loops [5], [14].

7.5. Contextual Innovation in Resource-Limited Settings: Despite limitations, several rural TEIs showcased creative approaches such as offline video modules and community-based peer learning. These innovations, though modest, reflected deep local understanding and adaptation—demonstrating that inclusivity need not depend solely on expensive technologies [8], [9].

8. Synthesis and Interpretive Insights

The comparative evidence underscores that techno-pedagogical inclusion is not merely a question of resources but of institutional culture and leadership commitment. Faculty digital competence and empathetic understanding of slow learners act as crucial mediators between technological availability and actual inclusivity.

While private-urban TEIs have achieved operational excellence, their practices risk becoming performance-centric without sustained reflection on learner diversity. Conversely, rural TEIs highlight the importance of pedagogical creativity and relational empathy even in technology-deficient environments.

The study reinforces the argument that inclusive techno-pedagogy must evolve as a balanced integration of digital infrastructure, faculty preparedness, and humanistic teaching values—embodying the spirit of NEP-2020's call for equity, inclusion, and innovation.

Challenges, Policy Implications, and Recommendations

The integration of techno-pedagogical practices in inclusive teacher education is a multidimensional process shaped by institutional culture, infrastructure, human resources, and policy alignment. Although the preceding results demonstrated promising trends—particularly in urban and private institutions—several systemic challenges hinder the full realization of inclusive digital pedagogy across the educational ecosystem. This section offers a detailed exploration of these challenges, interprets their broader policy implications, and presents targeted recommendations to enhance the inclusivity and sustainability of techno-pedagogical frameworks in teacher education institutions (TEIs).

Major Challenges in Implementing Techno-Pedagogical Inclusion

1. Infrastructure Disparities and the Persistent Digital Divide: The data clearly indicate a significant technological gap between urban and rural TEIs. While private and government-urban colleges benefit from advanced infrastructure and high-speed connectivity, rural institutions struggle with limited bandwidth, outdated equipment, and unreliable power supply. Such disparities directly constrain the ability of teachers to integrate assistive technologies, conduct blended learning sessions, or provide individualized learning support to slow learners. This challenge not only reflects economic inequity but also signals a deeper digital marginalization that undermines the inclusive intent of the National Education Policy (NEP-2020).

2. Insufficient Faculty Digital Competence and Confidence: Despite widespread recognition of technology's role in inclusive education, many faculty members—particularly in rural institutions—lack the necessary digital fluency and pedagogical confidence to use ICT tools effectively. The absence of continuous professional development programs leads to stagnant practices where teachers rely on traditional, lecture-dominated methods. Faculty members who were trained decades ago often express apprehension toward digital transformation, perceiving it as an administrative burden rather than an instructional enhancement. This competence gap directly limits the scope of differentiated instruction and adaptive learning strategies essential for slow learners.

3. Fragmented Policy Implementation and Bureaucratic Constraints: While national and state-level policies (such as NEP-2020, NCFTE-2009, and the ICT in Education Framework) advocate for inclusive and digital pedagogy, their institutional translation remains uneven. Government TEIs often face procedural delays, budgetary restrictions, and lack of monitoring mechanisms. Many institutions possess ICT or inclusion policies only on paper, with negligible operationalization. Additionally, there exists limited synergy between the Departments of Education, Technology, and Disability Affairs, resulting in fragmented implementation.

4. Lack of Contextual Adaptation in Technological Solutions: Several TEIs—especially those adopting commercial or standardized platforms—tend to overlook the contextual realities of learners with varied cognitive and linguistic needs. Imported or one-size-fits-all digital tools fail to accommodate slow learners from non-English-speaking backgrounds or those with low digital literacy. As a result, even technologically equipped institutions sometimes perpetuate exclusion under the guise of modernization. This highlights the necessity for localized, multilingual, and culturally responsive digital resources.

5. Inadequate Monitoring, Evaluation, and Feedback Mechanisms: There is a notable absence of robust assessment systems to evaluate the effectiveness of techno-pedagogical interventions in inclusive settings. Data-driven monitoring remains underdeveloped, especially in government and rural institutions. Without systematic evaluation, institutions fail to identify the impact of digital tools on learner progress or to refine pedagogical approaches. The lack of performance indicators tied to inclusivity further discourages long-term innovation.

6. Socio-Cultural and Psychological Barriers: Beyond technical challenges, there exist deep-rooted socio-cultural biases that marginalize slow learners within competitive teacher education environments. The social stigma associated with “slow learning” often discourages students from seeking technological assistance. Teachers, constrained by rigid curricula and examination pressure, sometimes prioritize completion of syllabus over individualized attention. This socio-cultural resistance complicates the implementation of inclusive practices, even where resources exist.

Policy Implications

The challenges identified above have significant implications for educational policy, institutional governance, and teacher preparation programs.

1. Reinterpreting NEP-2020 through the Lens of Digital Inclusivity: NEP-2020 emphasizes equity, accessibility, and the use of technology for transformative education. However, its successful implementation depends on nuanced interpretation at the institutional level. TEIs must view technology not merely as a delivery mechanism but as a pedagogical equalizer that can bridge learning differences. Policies must prioritize adaptive and assistive technologies tailored to diverse learner needs, especially in teacher training curricula.

2. Integrating Techno-Inclusivity in NCFTE and B.Ed. Curricula: The National Curriculum Framework for Teacher Education (NCFTE-2009) provides the philosophical foundation for teacher education. Yet, techno-pedagogical inclusivity is still treated as an elective or peripheral component. Policymakers should integrate mandatory modules on Digital Inclusion Pedagogy—covering assistive tools, Universal Design for Learning (UDL), and AI-driven personalization—into all teacher training programs.

3. Strengthening Institutional Autonomy and Funding Mechanisms: Government TEIs, especially in rural areas, need greater administrative and financial autonomy to invest in digital infrastructure and localized content development. Policy frameworks should enable decentralized decision-making, where institutions can customize ICT budgets, form public-private partnerships, and adopt open-source solutions. The current top-down funding approach often delays resource deployment and restricts innovation.

4. Establishing Standards and Benchmarks for Inclusive Digital Pedagogy: There is an urgent need to develop national benchmarks for measuring techno-pedagogical inclusivity. These benchmarks should include parameters such as accessibility compliance, assistive technology integration, inclusive assessment design, and learner satisfaction metrics. Aligning these with NAAC and NCTE accreditation processes will institutionalize accountability and encourage continuous improvement.

5. Data Governance and Digital Ethics in Inclusive Education: As TEIs adopt AI-based learning analytics and adaptive platforms, ethical considerations surrounding data privacy, consent, and algorithmic fairness become critical. Policymakers must ensure that institutional ICT policies align with digital ethics frameworks to prevent misuse of learner data—especially sensitive information related to disabilities or learning challenges.

Recommendations

Drawing from the data analysis and policy interpretations, the following recommendations are proposed for creating a robust, equitable, and contextually sensitive techno-pedagogical ecosystem in teacher education:

1. Institutional Level Recommendations

- **Digital Infrastructure Equalization:** Introduce targeted funding schemes (similar to RUSA or PMGDISHA) to strengthen digital infrastructure in rural and semi-urban TEIs.
- **Inclusive Resource Centers:** Establish “Digital Inclusion Hubs” within each TEI, equipped with assistive tools (screen readers, tactile learning aids, adaptive keyboards) and curated multimedia content for slow learners.
- **Blended Learning Ecosystems:** Encourage hybrid teaching models that combine synchronous instruction with self-paced digital modules, allowing slow learners to revisit complex topics independently.
- **Continuous Faculty Development:** Institutionalize mandatory ICT-inclusivity training programs every semester. Faculty certification in inclusive digital pedagogy should be a prerequisite for promotion or accreditation.

2. Pedagogical Recommendations

- **Adopt Universal Design for Learning (UDL):** Encourage flexible curriculum design that offers multiple means of engagement, representation, and expression for diverse learners.
- **Integrate AI and Data Analytics for Personalized Support:** Utilize adaptive learning platforms to monitor learner progress and recommend individualized learning paths.
- **Promote Collaborative and Peer-Learning Approaches:** Use digital discussion boards and group projects to enhance social inclusion among slow learners.
- **Content Localization:** Develop bilingual or vernacular digital resources to ensure accessibility for learners from diverse linguistic backgrounds.

3. Policy and Administrative Recommendations

- **National Framework for Inclusive EdTech:** The Ministry of Education should develop a comprehensive framework guiding inclusive digital pedagogy across TEIs, harmonizing the efforts of NCTE, NCERT, and CIET.
- **Accreditation and Evaluation:** Make “Inclusive Techno-Pedagogical Practices” a mandatory parameter in NAAC and NCTE accreditation scorecards.
- **Performance-Based Funding:** Link government grants and incentives to measurable improvements in inclusivity indices and digital readiness.
- **Monitoring and Reporting Systems:** Create an online “Inclusive Education Dashboard” where TEIs periodically upload data on infrastructure, faculty training, learner engagement, and assistive technology use.

4. Societal and Ethical Recommendations

- **Awareness Campaigns:** Conduct sensitization programs to dismantle the stigma around slow learners and promote the concept of differently-paced learning.

- **Inclusive Digital Citizenship:** Encourage ethical and empathetic use of digital tools through value-based education modules integrated into teacher training programs.
- **Public-Private Partnerships:** Collaborate with EdTech firms to co-develop affordable assistive technologies tailored to Indian socio-linguistic contexts.

Future Directions

Future research should move beyond descriptive analysis to interventional studies that evaluate the direct impact of specific techno-pedagogical strategies on slow learner outcomes. Mixed-method longitudinal research can help establish causal relationships between teacher preparedness, digital tools, and learner progress. Additionally, emerging technologies such as generative AI, AR/VR-assisted learning, and cognitive analytics hold immense potential for enhancing inclusivity if deployed ethically and contextually.

Furthermore, cross-regional studies comparing Indian TEIs with international benchmarks (for example, Finland or Singapore's inclusive EdTech ecosystems) can provide valuable insights for policy transfer and indigenization. The study reveals that techno-pedagogical inclusion in teacher education remains an aspirational yet attainable goal. The real challenge lies not in technology acquisition but in its purposeful integration into inclusive pedagogical practice. For slow learners to truly benefit, digital transformation must be grounded in empathy, equity, and evidence-based decision-making. Institutional leaders, policymakers, and educators must collaborate to ensure that the digital revolution in education does not deepen divides but rather becomes the foundation of a just, accessible, and human-centered teacher education system.

CONCLUSION

This study comprehensively examined the integration of techno-pedagogical practices in inclusive education, focusing on the support mechanisms for slow learners across diverse teacher education institutions. Through a comparative mixed-method analysis, it revealed that while digital technologies have begun transforming pedagogical engagement, disparities in infrastructure, faculty competence, and policy execution continue to limit their inclusive potential. Urban and private TEIs demonstrated higher technological readiness but often lacked contextual adaptation for learner diversity, whereas rural and government institutions displayed stronger empathy and community orientation but suffered from infrastructural and training deficits. The findings underscore that inclusivity in the digital era is not solely a function of access to technology but of its meaningful pedagogical use—anchored in empathy, adaptability, and reflective practice. The study also emphasized the necessity of embedding techno-inclusivity within national frameworks such as NEP-2020 and NCFTE-2009, while calling for institutional accountability through structured monitoring and evaluation mechanisms. It advocates for the establishment of inclusive digital ecosystems that balance technological innovation with humanistic teaching principles. Ultimately, the research concludes that a sustainable model of inclusive teacher education demands a triadic synergy among policy, pedagogy, and technology. When integrated holistically, this approach has the potential to transform teacher education into a truly equitable, data-informed, and learner-centered system—ensuring that no learner, regardless of pace or background, is left behind in the digital transformation of education.

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