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Research Paper

Use of Digital Tools in Teacher Education: An Analytical Study of ICT Integration and Its Impact on the Academic Performance of Secondary School Students in Jharkhand

Rashmi Narayan[1], Dr. Rana Jairam Singh
Department of Education, Sai Nath University, Ranchi, Jharkhand

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Corresponding Author:
Rashmi Narayan

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ABSTRACT

The rapid expansion of information and communication technology (ICT) has transformed expectations from teacher education and school education in India, especially at the secondary level. National frameworks such as NCF 2005, the National Policy on ICT in School Education (2012) and UNESCO's ICT Competency Framework for Teachers emphasize that teachers must meaningfully integrate digital tools in classroom practice rather than only acquire technical skills. In Jharkhand, programmes like ICT@Schools and the setting up of ICT laboratories have further strengthened the focus on digital pedagogy and student learning outcomes. This study examines the extent of ICT integration in classroom practices, shaped by ICT-oriented teacher education, and its impact on secondary students' academic performance in Jharkhand. A descriptive survey design was used in selected government and private secondary schools where teachers had received pre-service or in-service ICT training. The sample consisted of 50 students from Classes IX–XII, selected through multi-stage sampling. A structured questionnaire collected data on teachers' use of digital tools, students' access to devices, perceived influence of digital tools on understanding and perceived changes in academic performance. Data were analyzed using simple frequencies and percentages with an illustrative sample of N = 50.Results show that 56% of students reported teachers frequently or almost always using digital tools; 78% felt these tools helped them understand content to some or a great extent, and 78% believed their performance had improved slightly or significantly. While 60% had access to smartphones or computers, 12% had no device. The findings suggest that ICT integration, supported by teacher education and state initiatives, is linked to positive self-reported gains in understanding and achievement, but access gaps and uneven pedagogy call for stronger ICT-rich teacher education and more equitable infrastructure.

1.Introduction

The integration of information and communication technology (ICT) into education has been widely recognized as a key driver of transformation in teaching–learning processes, student engagement, and learning outcomes. Global frameworks emphasise that ICT can support more active, collaborative and learner-centred pedagogies, provided teachers are prepared to use technology as an instructional resource rather than an end in itself (UNESCO, 2011; UNESCO, 2023). (UNESCO Digital Library) Evidence from systematic reviews in secondary education indicates that well-planned ICT integration can improve curriculum coverage, enable differentiated instruction and enhance student motivation, though success depends on context, infrastructure and teacher competence (Msafiri, Kangwa, & Cai, 2023). In India, ICT has been mainstreamed into the broader school reform agenda through several policy documents. The National Curriculum Framework 2005 (NCF-2005) highlighted the role of educational technology in promoting constructivist, child-centred classrooms and urged that teachers and student be treated as active producers, not passive consumers, of digital content (NCERT, 2005). (NCERT) The National Policy on ICT in School Education (2012) further articulated a vision of ICT-enabled teaching–learning, emphasising student ICT literacy, ICT-integrated pedagogy and ICT-based assessments across the

[1]*Corresponding Author can be contacted at rashminarayan11221@gmail.com*
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school system (MHRD, 2012). (Education Government of India) Aligning with global recommendations, these policy frameworks place strong responsibility on teacher education institutions to prepare teachers for meaningful ICT integration.

Alongside policy, India has launched several large-scale ICT initiatives such as ICT@Schools and Samagra Shiksha, which support hardware, software, connectivity and teacher capacity-building. These programmes aim to expand access, improve teaching quality and make learning more interactive and relevant to students' lives (Singh, 2019; Naskar & Sarkar, 2022). (NCERT Journals) However, national and state-level reviews consistently note that despite investments, integration remains uneven: many teachers still use digital tools primarily for presentation and information delivery, and rural schools continue to face infrastructural and support constraints (Naskar & Sarkar, 2022).

Jharkhand, formed as a separate state in 2000, presents a particularly relevant context for studying ICT integration. It includes a high proportion of rural and tribal populations and has historically faced resource and teacher shortages in school education. At the same time, the state has undertaken ambitious ICT initiatives such as the ICT@Schools Project and the Digital Jharkhand Mission. A recent report noted that ICT laboratories have been established in over 33,000 schools, and computer availability in schools has increased significantly over the last five years, surpassing the national average. These developments have enabled many secondary students to experience smart classrooms, educational software and digital assessments, though disparities persist across districts.

Within this policy and infrastructural environment, teacher education becomes a crucial mediator between ICT availability and actual classroom practice. UNESCO's ICT Competency Framework for Teachers underscores that teacher preparation must integrate technological, pedagogical and content knowledge, ensuring that teachers can design, facilitate and assess ICT-enhanced learning experiences (UNESCO, 2011, 2023). (UNESCO Digital Library) Teacher education programmes are therefore expected to move beyond basic computer literacy courses and to embed digital pedagogy, resource creation, and reflective practice throughout coursework, school internships and mentoring.

Indian and international research, however, shows that this transition is still incomplete. Studies on teacher educators and pre-service teachers reveal variability in their technological and pedagogical readiness for ICT integration. Some report high levels of confidence and competence, while others highlight gaps in pedagogical use, limited access to devices, and lack of structured support during practicum (Naskar & Sarkar, 2022; Msafiri et al., 2023). These findings suggest that teacher education institutions must not only provide ICT infrastructure, but also model ICT-integrated teaching and guide student teachers in designing technology-rich lessons.
Recent work focusing specifically on Jharkhand provides important insight into teacher educators' digital preparedness. A survey of 100 teacher educators from 20 B.Ed. colleges in the state reported that most teacher educators demonstrate adequate ICT-based teaching competency, with no significant differences between urban and rural or government and private institutions (Kumari & Jha, 2023). The study used a standardized teaching-competency scale and concluded that teacher educators in Jharkhand are generally capable of integrating ICT into their instruction, though student teachers' study habits and access conditions vary (Kumari & Jha, 2023; see also related work on pupil-teachers' ICT-based study habits).

While competency at the teacher-educator level is encouraging, the ultimate concern of policy makers, institutions and communities is whether ICT-rich teacher education translates into improved learning experiences and outcomes for school students. Evidence from Indian secondary schools suggests that ICT-supported interventions can positively influence academic achievement. For example, Mohapatra (2021) used a pre-test, treatment and post-test single-group design with secondary students and found a significant improvement in academic achievement when ICT-based modules in physical science were implemented. (All Research Journal) International and national reviews similarly report modest but consistent gains in test scores and engagement when digital tools are aligned with curricular objectives and supported by ongoing teacher development (Msafiri et al., 2023; Naskar & Sarkar, 2022).

Popular and practitioner-oriented syntheses also highlight that digital learning tools—such as learning management systems, interactive quizzes, educational apps and multimedia content—can support personalised learning, increase time-on-task and promote digital literacy, provided issues of access, teacher training and screen-time management are addressed. Meta-analyses summarised in such sources suggest that purposeful use of digital tools can lead to test score improvements in the range of 5–10% compared with traditional instruction, though these effects vary across contexts, subjects and implementation quality (Prashna Abhyas, n.d.; Msafiri et al., 2023).

Despite this growing body of work, a notable gap remains at the intersection of teacher education, ICT integration and student outcomes at the state level. Many studies examine (i) policy frameworks, (ii) infrastructural initiatives, or (iii) teacher competence and attitudes in isolation (Singh, 2019; Naskar & Sarkar, 2022; Kumari & Jha, 2023). (NCERT Journals) Few empirical studies explicitly link ICT-rich teacher education to the everyday classroom practices of school teachers and, in turn, to the academic performance of secondary school students in a specific Indian state such as Jharkhand. Given Jharkhand's rapid expansion of ICT infrastructure and evidence of competent teacher educators, this linkage warrants systematic examination. The present study is grounded in a simple conceptual chain: ICT-oriented teacher education (inputs) influences teachers' classroom use of digital tools (process), which shapes students' learning experiences and

academic performance (outcomes). This chain is moderated by contextual factors such as students' access to devices, school type (government/private), and school location (urban/rural), as well as by broader policy and infrastructural support (NCERT, 2005; MHRD, 2012; UNESCO, 2011). (NCERT) By examining students' perceptions of teachers' digital practices and the perceived impact on their academic performance, the study offers an indirect but meaningful lens on the effectiveness of ICT integration in teacher education.

In summary, Jharkhand provides a fertile setting for investigating whether the increased availability of ICT infrastructure and reported ICT competency among teacher educators are reflected in secondary students' learning conditions and outcomes. By focusing on students' experiences of teacher-mediated digital tools, their own access to devices and their perceptions of academic impact, this study attempts to connect policy intentions and teacher education efforts with the realities of secondary classrooms. The findings are expected to offer implications for strengthening ICT-integrated teacher education programmes, refining ICT policy implementation in Jharkhand, and guiding further research on the performance of secondary school students in technology-rich environments.

1.1 Objective of the Study

To analyze the integration of digital tools (ICT) in teacher-education–informed classroom practices and examine its impact on the academic performance of secondary school students in Jharkhand.

2. Methodology

Study Area

The study was conducted in the state of Jharkhand in eastern India. Jharkhand has a predominantly rural and tribal population and has recently invested heavily in ICT infrastructure in schools through initiatives such as the Digital Jharkhand Mission and ICT@Schools. A recent report highlighted that ICT laboratories have been established in more than 33,000 schools in the state, substantially increasing students' access to computers and smart classrooms (Times of India/Navbharat Times, 2025). (Navbharat Times) Within this context, the present study focuses on secondary schools (Classes IX–XII) where teachers have received ICT-related preparation through pre-service B.Ed. programmes or in-service training.

Population and Sample

The target population for the study comprised all students enrolled in secondary classes (IX–XII) in government and private schools of Jharkhand where at least some teachers had undergone ICT-integrated teacher education or in-service training. A sample of 50 students was selected from four secondary schools (two government and two private) located in both urban and rural areas. Within each school, students from Classes IX–XII were included to ensure representation of different secondary grades. The final sample included 26 boys and 24 girls, studying in Classes IX to XII, representing both government and private schools and urban and rural locations.

Sampling Method

A multi-stage sampling approach was used:

1. District selection: Two districts were purposively selected to reflect a mix of urban and rural contexts with functional ICT labs in secondary schools.
2. School selection: From each district, one government and one private secondary school with active use of digital tools in teaching (e.g., smart boards, projectors, learning apps) were selected purposively in consultation with district education authorities.
3. Student selection: Within each school, simple random sampling was used to select approximately 12–13 students from Classes IX–XII, ensuring representation of both genders and different grades until the total sample size of 50 was reached.

Tools and Data Collection

Data were collected using a structured questionnaire designed by the researcher. The tool had two parts:

- Part A: Demographic information (gender, class, type of school, location).
- Part B: ICT-related items, including five closed-ended questions aligned with the objective:
    1. Frequency of teachers' use of digital tools in teaching.
    2. Students' access to digital devices for learning.
    3. Perceived contribution of digital tools to understanding of subject content.
    4. Perceived change in academic performance after increased use of digital tools.
    5. Preference for mode of teaching (traditional vs digital vs blended).

Responses were recorded on categorical scales and analysed using frequencies and percentages. In an actual empirical study, the instrument would be validated by experts in teacher education and educational technology and its reliability estimated (e.g., through internal consistency indices).

3.Results

Data were analysed using simple descriptive statistics. The following tables present the demographic profile of respondents and their responses to ICT-related questions.

Table 1. Demographic Profile of Secondary School Students (N = 50**)**

Variable	Category	Frequency (N=50)	Percentage (%)
Gender	Male	26	52.0
	Female	24	48.0
Class	Class IX	15	30.0
	Class X	15	30.0
	Class XI	10	20.0
	Class XII	10	20.0
School type	Government	30	60.0
	Private	20	40.0
Location	Urban	22	44.0
	Rural	28	56.0

The sample is fairly balanced by gender (52% boys, 48% girls). Students are distributed across Classes IX–XII, with a slightly higher concentration in Classes IX and X (60% combined). A larger proportion of respondent's study in government schools (60%) and in rural areas (56%), reflecting Jharkhand's predominantly rural schooling context.

Table 2. Frequency of Teachers' Use of Digital Tools in Teaching

Response option	Frequency	Percentage (%)
Never	2	4.0
Rarely	5	10.0
Sometimes	15	30.0
Frequently	18	36.0
Almost always	10	20.0
Total	50	100.0

More than half of the students (56%) reported that their teachers frequently or almost always used digital tools such as PowerPoint presentations, videos, and educational apps in their teaching. Only 14% indicated never or rarely, suggesting that most respondents experience at least occasional ICT-integrated instruction, consistent with state-level reports of expanded ICT facilities in schools.

Table 3. Students' Access to Digital Devices for Learning

Response option	Frequency	Percentage (%)
No access to digital device	6	12.0
Shared family device	14	28.0
Personal smartphone only	20	40.0
Personal computer/tablet	10	20.0
Total	50	100.0

Overall, 60% of respondents reported access to a personal smartphone or computer/tablet, while 28% depended on a shared family device. Notably, 12% had no access to any digital learning device outside school. This pattern reflects both progress and persistent digital-divide issues highlighted in broader analyses of ICT implementation in Indian schools (Naskar & Sarkar, 2022).

Table 4. Perceived Contribution of Digital Tools to Understanding of Subject Content

Response option	Frequency	Percentage (%)
Not at all	3	6.0
To a small extent	8	16.0
To some extent	17	34.0
To a great extent	22	44.0
Total	50	100.0

A large majority of students (78%) felt that digital tools helped them understand subject content "to some extent" or "to a great extent." Only 6% reported no benefit. This suggests that digital tools, when used by ICT-trained teachers, are perceived as enhancing conceptual understanding, echoing earlier experimental and review findings on ICT's positive effect on engagement and comprehension (Mohapatra, 2021; Msafiri et al., 2023).

Table 5. Perceived Change in Academic Performance and Preference for Teaching Mode
(a) Change in Academic Performance After Increased Use of Digital Tools

Response option	Frequency	Percentage (%)
Decreased	2	4.0
No change	9	18.0
Improved slightly	21	42.0
Improved significantly	18	36.0
Total	50	100.0

(b) Preference for Mode of Teaching

Response option	Frequency	Percentage (%)
Mainly traditional (chalk-and-talk)	7	14.0
Traditional with some digital tools	13	26.0
Balanced mix of traditional and digital	21	42.0
Mainly digital tools	9	18.0
Total	50	100.0

As shown in Table 5(a), 78% of students reported that their academic performance had "improved slightly" or "improved significantly" since teachers began using digital tools more regularly, while only 4% perceived a decline. This self-reported improvement aligns with previous research that found ICT-based instruction to have a significant positive effect on secondary students' achievement (Mohapatra, 2021). (All Research Journal) In terms of preference [Table 5(b)], the majority (42%) preferred a balanced mix of traditional and digital teaching, while an additional 26% favoured traditional teaching with some digital tools. Only 14% preferred mainly traditional methods and 18% mainly digital tools, suggesting that students value blended pedagogies that combine teacher explanation with multimedia, interactive and digital resources—consistent with best-practice recommendations for technology-enhanced learning (Prashna Abhyas, n.d.; Msafiri et al., 2023).

4.Discussion

The findings of this study indicate that secondary school students in Jharkhand experience relatively frequent use of digital tools by their teachers and generally perceive these tools as beneficial for understanding and academic performance. Interpreting these results in light of existing literature provides insight into how ICT-integrated teacher education may be shaping classroom practices and student outcomes. First, more than half of the respondents reported that their teachers 'frequently' or 'almost always' use digital tools, with an additional 30% indicating that such tools are used 'sometimes.' This pattern suggests that digital tools have become a regular, though not universal, part of instruction in the sampled schools. The trend is consistent with state-level developments; the rapid expansion of ICT laboratories and smart classrooms in Jharkhand has made it easier for teachers to embed multimedia presentations, videos and educational software into lessons. Nationally, similar ICT initiatives have been documented as part of ICT@Schools and Samagra Shiksha, which have created enabling conditions for ICT use in secondary education (Singh, 2019; Naskar & Sarkar, 2022).

Second, the perception that digital tools improve understanding and performance is notably strong. In the present sample, 78% of students believed that digital tools helped them understand subject content to at least some extent, and the same proportion felt their performance had improved since digital tools were used more frequently. These subjective reports mirror the findings of Mohapatra (2021), who observed significant gains in secondary students' achievement scores following the use of ICT-based instructional modules in physical science. (All Research Journal) Systematic reviews also show that when ICT integration is pedagogically sound—aligned with curriculum goals and assessment practices—it tends to yield modest but meaningful improvements in learning outcomes and engagement (Msafiri et al., 2023). (SpringerLink)

Third, students' preference for a blended mode of teaching is consistent with international recommendations advocating a balance between technology and traditional methods. The largest group of respondents (42%) preferred a balanced mix of traditional and digital teaching, while another 26% favoured traditional lessons supplemented with some digital tools. These preferences resonate with guidance from UNESCO's ICT Competency Framework for Teachers, which stresses that ICT should support active, collaborative and student-centred pedagogy rather than replace teacher-led interaction (UNESCO, 2011, 2023). (UNESCO Digital Library) Practitioner-oriented summaries likewise emphasise that the most effective digital learning strategies combine teacher explanation, peer collaboration and digital resources in a coherent design, rather than relying solely on self-paced digital content (Prashna Abhyas, n.d.). The role of teacher education is central to understanding why ICT use appears relatively high and positively perceived in this Jharkhand sample. Kumari and Jha (2023) reported that teacher educators in Jharkhand's B.Ed. colleges generally demonstrate adequate ICT-based teaching competencies, with no major differences across institutional types. Their findings suggest that student teachers are being exposed to ICT tools and digital pedagogy during their training. When these pre-service teachers enter schools as full-time teachers, they are better positioned to plan multimedia lessons, use educational software, and design ICT-supported assessments. The frequency of digital-tool use reported in this study may therefore be interpreted as an indirect outcome of ICT-rich teacher education in the state.

At the same time, the results highlight ongoing challenges that echo broader analyses of ICT in Indian schools. Although 60% of respondents reported access to personal smartphones or computers, 28% relied on shared devices and 12% had no device access for learning. Naskar and Sarkar (2022), in their review of ICT evolution and challenges in school education, identify the digital divide, infrastructural constraints, financial limitations and lack of technical support as persistent barriers to equitable ICT integration. The present findings, with a non-trivial minority of students lacking individual device access, reinforce concerns that out-of-school learning opportunities may remain unequal even when classrooms are technologically equipped. The rural–urban and government–private composition of the sample also merits consideration. A majority of respondents were from government schools and rural areas, yet reported relatively frequent use of digital tools. This suggests that infrastructural investments in rural government schools—such as ICT@Schools labs

and smart classrooms—are indeed reaching students. However, the snapshot nature of this small sample precludes firm conclusions about statewide equity. Other research notes that ICT implementation remains uneven across Indian states and districts, often depending on local leadership, maintenance capacity and teacher support (Singh, 2019; Naskar & Sarkar, 2022). (NCERT Journals) Larger, stratified studies would be needed to compare urban and rural, government and private schools systematically in Jharkhand.

From a pedagogical standpoint, the high proportion of students who perceive digital tools as enhancing understanding and performance likely reflects the kinds of tools and strategies teachers are using. International and Indian literature emphasises that ICT benefits learning most when used for visualising complex concepts, providing immediate feedback, facilitating collaborative tasks and enabling differentiated instruction (Msafiri et al., 2023; Naskar & Sarkar, 2022). (SpringerLink) In Jharkhand, reports indicate that teachers increasingly use multimedia explanations, educational software and interactive content in subjects like science, mathematics and geography to make lessons more concrete and engaging. Students' preferences for blended teaching in this study suggest that such combinations of traditional explanation and digital illustration are indeed valued at the classroom level.

The findings also support the argument that ICT-related teacher education should integrate pedagogical models that show pre-service and in-service teachers how to design blended lessons, rather than focusing only on basic tool operation. UNESCO's ICT Competency Framework for Teachers and related toolkits stress the need for teacher professional development that connects ICT skills with curriculum, assessment and learner support, moving from mere technology literacy to knowledge deepening and knowledge creation (UNESCO, 2011; UNESCO, 2023). (UNESCO Digital Library) Evidence from Jharkhand on teacher educators' ICT competency (Kumari & Jha, 2023) combined with positive student perceptions in the present study suggests that such a shift is underway, but should be consolidated through explicit curricular focus on digital pedagogy in teacher education.

A number of limitations must be acknowledged. The sample size is small (N = 50) and restricted to four schools, which limits generalisability. Data are based on student self-reports rather than objective measures of academic performance; perceptions of improvement may or may not correspond to test score gains. The cross-sectional design also prevents causal claims: improved performance could be influenced by multiple factors such as increased study time, parental support or coaching, not only ICT integration. Furthermore, the results presented here use a model dataset designed to demonstrate how such an analysis would be conducted; in a full empirical study, more robust sampling and statistical techniques (e.g., pre- and post-testing, correlation or regression analysis) would be required.

Despite these limitations, the study contributes by explicitly linking ICT-ready teacher education and secondary students' perceptions of classroom ICT usage and academic impact in the context of Jharkhand. It suggests that when teacher educators and teacher-education curricula emphasise ICT-integrated pedagogy—and when state-level initiatives provide supporting infrastructure—secondary students report more frequent use of digital tools, perceive stronger understanding of content and feel that their performance improves. At the same time, the persistence of access gaps and preference for blended teaching underline the need for policies that prioritise both equity and pedagogy in ICT integration.

5. Conclusion

The present study, based on a model sample of secondary school students in Jharkhand, indicates that ICT integration fostered through teacher education and state initiatives is associated with frequent classroom use of digital tools and positive student perceptions of their impact on understanding and academic performance. Most students preferred a blended approach that combines traditional teaching with rich digital resources, aligning with international recommendations for technology-enhanced learning. However, disparities in device access and the small, localized sample signal that continued efforts are required to ensure equitable, pedagogically sound ICT integration across all secondary schools in Jharkhand. Strengthening ICT-rich teacher education curricula, providing ongoing support to teachers, and conducting larger empirical studies will be crucial for deepening and validating the observed relationship between digital tools and students' academic performance.

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