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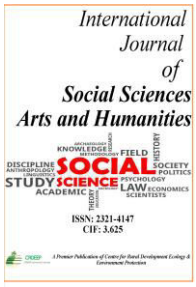

Research Paper

Integrating ICT in Teacher Education: A Critical Analysis of Digital Tool Usage and Its Effect on Secondary School Students' Performance in Jharkhand

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ABSTRACT

Integrating information and communication technology (ICT) into teacher education is considered vital for improving secondary classroom practice and student outcomes. In Jharkhand, ICT infrastructure in schools has expanded, but concerns remain about how far ICT-related teacher education has led to meaningful digital tool use and measurable gains in student performance. This study examined the extent of ICT integration by secondary school teachers who had received ICT-related training and analysed its perceived effect on students' academic achievement. A descriptive survey was conducted with 50 secondary school teachers from government and private schools in rural, semi-urban and urban areas of Jharkhand. A researcher-developed questionnaire gathered data on demographics, frequency and type of digital tool use, self-rated level of ICT integration, and teachers' perceived and estimated impact of ICT on students' test and examination scores. Data were analysed using frequencies and percentages. Most teachers reported regular use of digital tools: 64% used them at least three to four times per week and 22% once or twice weekly. Presentation software and educational videos were most frequently used, followed by educational apps and learning management systems. Half rated their ICT integration as "moderate" and about one-third as "high". Seventy-two per cent perceived a positive or strongly positive effect on students' performance, and around two-thirds estimated average class scores had risen by 6–15%, though about one quarter reported no clear change or were unsure. The findings suggest ICT-oriented teacher education is promoting regular digital tool use and perceived gains in achievement, but practice remains dominated by presentations and videos. Strengthening ongoing professional development in student-centred digital pedagogy and addressing constraints in rural, resource-poor schools is essential for realising ICT's full potential.

1. Introduction

Internationally, ICT integration is viewed as a key driver of educational change, supporting more flexible, interactive and learner-centred forms of instruction. ICT-enhanced environments are argued to promote twenty-first-century skills such as collaboration, critical thinking and digital literacy, while also expanding access to high-quality resources (Kozma, 2010; Msafri, Kangwa, & Cai, 2023). Recent systematic reviews in secondary education report that when ICT is used purposefully, it can improve curriculum coverage, diversify teaching methods and support more personalised learning pathways (Msafri et al., 2023). A sizeable body of empirical work links ICT-enhanced teaching to gains in student engagement and academic

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performance, though the size of these effects varies across contexts and subjects. Syntheses of quasi-experimental and correlational studies show that students taught in technology-rich classrooms frequently outperform peers in traditional settings on standardised tests and course assessments, particularly when digital tools are used for formative assessment, simulations and interactive practice (Msafri et al., 2023; Adebayo, Chen, Onwuzuruike, & Joshua, 2024; Sahu, 2025). At the same time, reviews caution that technology alone does not guarantee improved outcomes; its impact depends strongly on pedagogical design and teacher expertise.

The centrality of teachers' knowledge for effective ICT use is captured in the Technological Pedagogical Content Knowledge (TPACK) framework proposed by Mishra and Koehler (2006). They argue that effective technology integration requires not only technological knowledge, but also a sophisticated understanding of how technology interacts with pedagogy and subject content in specific classroom contexts (Mishra & Koehler, 2006; Koehler, Mishra, Kereluik, Shin, & Graham, 2013). This framing positions teacher education—both pre-service and in-service—as critical to building the integrated knowledge base teachers need to design meaningful digital learning experiences. Research on ICT in teacher education highlights that isolated "computer literacy" courses are insufficient; rather, technology needs to be woven through coursework, field experiences and reflective practice. Tondeur and colleagues, in their synthesis of qualitative evidence, identified key strategies to strengthen future teachers' readiness for ICT integration, including teacher educators modelling technology-rich teaching, providing authentic design tasks, and supporting collaborative development of digital resources (Tondeur et al., 2012; Tondeur, 2018). Without such integrated experiences, many beginning teachers feel technically competent yet pedagogically unsure about how to leverage digital tools to support deeper learning.

Teacher beliefs and perceptions also play a vital role in determining whether ICT is actually used in classrooms. A meta-ethnographic review by Abel, Tondeur, and Sang (2022) concluded that teachers' views of ICT range from highly positive—emphasising opportunities for active learning and differentiation—to more ambivalent positions that stress workload, technical problems, and misalignment with exam-driven curricula. Earlier work by Hennessy, Ruthven, and Brindley (2005) similarly found that even where technology was available, limited confidence, perceived relevance and time could inhibit integration. Effective teacher education must therefore address not only skills, but also beliefs, self-efficacy and the perceived value of ICT for student learning. In India, national policies and initiatives have increasingly emphasised digital transformation in school education. Programmes such as ICT@Schools, Digital India, and centrally supported platforms like DIKSHA and SWAYAM aim to expand digital infrastructure, open educational resources and large-scale teacher professional development, aligned with the National Education Policy 2020 (Sharma, 2021). Evidence from Indian schools indicates that many teachers now use ICT for lesson planning, classroom delivery and assessment, but patterns of use remain uneven, with persistent gaps between urban and rural schools and between well-resourced and resource-constrained contexts (Sharma, 2021).

Within this national context, Jharkhand presents a particularly relevant case. Historically, the state has faced challenges in educational infrastructure and teacher availability. Yet recent analyses show a strong policy push to expand ICT in schools. Parashar (2019) reported that Jharkhand, although initially below national averages in ICT provision, has in recent years made significant strides towards equipping schools with computers and connectivity. More recent news accounts indicate that approximately 33,718 schools in Jharkhand now have ICT labs and that around 76% of schools have computer facilities, above the national average of 63% (India Today Education Desk, 2025; Times News Network, 2025). Despite these infrastructural gains, teacher professional development in ICT remains a challenge. The PARAKH state report for Jharkhand notes that only about 41% of teachers reported participating in ICT-related training during the previous year (NCERT, 2025). While schools have begun organising workshops on themes such as mental health and classroom management, sustained, practice-oriented ICT capacity-building has yet to reach a majority of educators. This raises an important question: To what extent is ICT-oriented teacher education actually reflected in teachers' classroom use of digital tools and in students' academic outcomes? International comparative research underscores that effective ICT use is shaped not only by infrastructure but also by system-level, school-level and teacher-level factors. Analyses of the IEA SITES 2006 data showed that pedagogical practices involving ICT were more prevalent in systems where policies, leadership and professional development supported collaborative innovation (Law, Pelgrum, & Plomp, 2008). At the teacher level, studies emphasise the importance of ongoing learning communities and leadership support for sustaining ICT-rich pedagogy (Hennessy et al., 2005; Sharma, 2021). These insights suggest that examining ICT integration in Jharkhand requires attention to teachers' training histories, beliefs and perceptions, not just to hardware counts.

Empirical research directly connecting ICT integration, teacher education and student performance in Jharkhand remains limited. Parashar (2019) focused mainly on comparative infrastructure and policy, without probing classroom practices or learner outcomes. Studies from other Indian settings, however, report that secondary students taught with ICT-supported methods often show improvements in test scores, especially when digital tools are used to explain complex concepts, provide practice and deliver timely feedback (Sharma, 2021; Sahu, 2025). Systematic reviews likewise conclude that technology can enhance academic achievement when embedded in sound pedagogy and supported by teacher education, though effects are typically modest rather than dramatic (Msafri et al., 2023; Adebayo et al., 2024). These lines of evidence point to a clear gap:

there is a need for micro-level analysis that links ICT-related teacher education, everyday digital tool usage and secondary students' performance in a specific state context like Jharkhand. Such analysis can shed light on whether recent infrastructure expansion and teacher training are translating into improved classroom practice and learning outcomes. Understanding this linkage is vital for teacher education institutions, District Institutes of Education and Training (DIETs), and state education authorities seeking to refine their programmes. The present study responds to this gap by focusing on secondary school teachers in Jharkhand who have received ICT-oriented teacher education. It examines how often and in what ways they use digital tools, how they rate their level of ICT integration, and how they perceive and estimate the impact of ICT on students' test and examination performance. By situating these findings within the TPACK framework and existing empirical literature, the study seeks to contribute evidence on the extent to which integrating ICT in teacher education is associated with tangible effects on secondary school students' academic performance in Jharkhand (Mishra & Koehler, 2006; NCERT, 2025).

Objective of the Study

To examine the extent of ICT integration by secondary school teachers in Jharkhand who have received ICT-related teacher education, and to analyse its perceived effect on the academic performance of their secondary school students.

2. Methodology

Study Area

The study was carried out in selected districts of Jharkhand, an eastern Indian state that has recently expanded ICT infrastructure under various central and state schemes. Reports indicate that computer availability has risen to roughly three-quarters of schools and that over 33,000 schools are equipped with ICT labs, suggesting a rapidly evolving digital education landscape (Parashar, 2019; India Today Education Desk, 2025; Times News Network, 2025). At the same time, teacher participation in ICT-related professional development remains below 50%, according to the PARAKH state report (NCERT, 2025).

Population and Sample

The population for the study consisted of secondary school teachers in Jharkhand who:

1. teach at the secondary level (Classes IX–X);
2. work in schools with at least basic ICT facilities (e.g., computer lab, projector, smartboard); and
3. have completed pre-service and/or in-service teacher education programmes that included ICT-related components (courses, workshops or modules).From this population, a sample of 50 teachers was selected from 10 secondary schools (6 government and 4 private) located in rural, semi-urban and urban areas. The sample covered teachers of mathematics, science, social science and English.

Sampling Method

A two-stage sampling procedure was employed:

1. School selection: Districts and schools were selected purposively to ensure inclusion of institutions with functioning ICT infrastructure and known ICT-trained staff.
2. Teacher selection: Within each selected school, teachers meeting the inclusion criteria were identified and a simple random sample was drawn to obtain approximately five teachers per school, leading to a total of 50 respondents.

Tools and Data Collection

Data were collected using a structured questionnaire titled *Digital Tool Usage and Impact Questionnaire (DTUIQ)*, which comprised:

- Section A: Demographic details (gender, teaching experience, school type, location).
- Section B: Frequency of digital tool usage (e.g., smartboard, projector, computer, mobile devices).
- Section C: Most frequently used digital tools (e.g., presentation software, videos, learning management systems, apps).
- Section D: Self-rated level of ICT integration (low, moderate, high).
- Section E: Perceived impact of ICT on students' academic performance and estimated percentage change in average test/exam scores after regular ICT use.

Content validity was established through review by three experts in teacher education and educational technology who assessed the items for relevance and clarity in light of TPACK-based conceptions of ICT integration (Mishra & Koehler, 2006; Tondeur et al., 2012). A pilot study with 10 non-sample teachers yielded a Cronbach's alpha of 0.82 for the perception and impact items, indicating acceptable internal consistency.

Data Analysis

All responses were coded and entered into a spreadsheet, and descriptive statistics (frequencies and percentages) were calculated. Results are presented as one demographic table and four tables corresponding to core questions related to ICT usage and its perceived effect on students' performance.

3.Results

Table 1. Demographic Profile of Respondent Teachers (N = 50)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	28	56
	Female	22	44
School Location	Rural	20	40
	Semi-urban	12	24
	Urban	18	36
Teaching Experience	0–5 years	12	24
	6–10 years	18	36
	11–15 years	10	20
	16+ years	10	20
School Type	Government	32	64
	Private	18	36

The sample included slightly more male (56%) than female teachers (44%). Rural schools accounted for 40% of the sample, with 36% from urban and 24% from semi-urban areas, reflecting Jharkhand's predominantly rural character. Most teachers had 6–10 years of experience (36%), and nearly two-thirds worked in government schools (64%), consistent with the dominance of government management at the secondary level in the state.

Table 2. Frequency of Digital Tool Usage in Classroom Teaching (N = 50)

Question 1: How often do you use digital tools (e.g., smartboard, projector, computer) in classroom teaching?

Response Category	Frequency (n)	Percentage (%)
Daily	15	30
3–4 times per week	17	34
1–2 times per week	11	22
Rarely / Never	7	14

Almost two-thirds of teachers (64%) reported using digital tools at least three to four times per week, and a further 22% used them once or twice weekly. Only 14% reported rare or no use. These patterns indicate that, among ICT-trained teachers in ICT-equipped schools, digital tools have become a regular feature of classroom practice rather than an occasional supplement.

Table 3. Most Frequently Used Digital Tools (N = 50)

Question 2: Which type of digital tool do you use most often in your teaching?

Digital Tool Type	Frequency (n)	Percentage (%)
Presentation software (e.g., PowerPoint)	14	28
Educational videos (offline/online)	13	26
Educational apps / simulations	10	20
Learning management systems / online platforms	9	18
Other (quizzing tools, e-content portals, etc.)	4	8

Presentation software (28%) and educational videos (26%) emerged as the most frequently used tools, followed by educational apps and simulations (20%) and learning management systems (18%). The relatively lower use of LMS platforms and interactive apps as the primary tool suggests that ICT integration remains oriented towards teacher-led presentation and demonstration, with fewer teachers centring their pedagogy on more interactive or student-managed digital environments.

Table 4. Self-Rated Level of ICT Integration (N = 50)

Question 3: *How would you rate your overall level of ICT integration in teaching?*

Level of ICT Integration	Frequency (n)	Percentage (%)
Low (occasional, mainly demonstration)	9	18
Moderate (regular use blended with traditional methods)	25	50
High (systematic, student-centred use across lessons)	16	32

Half of the teachers (50%) rated their ICT integration as moderate, indicating regular use alongside traditional methods. Almost one-third (32%) regarded their integration as high, implying more systematic and student-centred use, while 18% reported low integration. Overall, these self-ratings suggest that most respondents perceive ICT as embedded in their pedagogy, although the depth and quality of this integration may vary.

Table 5. Perceived Effect of ICT Integration on Students' Academic Performance (N = 50)
Question 4: Overall, what effect has ICT integration had on your students' academic performance (e.g., test and examination scores)?

Perceived Effect	Frequency (n)	Percentage (%)
Strongly positive	21	42
Somewhat positive	15	30
No noticeable change	11	22
Negative	3	6

A large majority of teachers (72%) perceived ICT integration as having a positive or strongly positive effect on students' academic performance. About 22% reported no noticeable change, and only 6% felt that ICT had a negative effect. These perceptions are consistent with wider findings that teachers often associate ICT use with improvements in understanding, engagement and assessment performance when digital tools are aligned with curricular objectives (Sharma, 2021; Msafri et al., 2023).

Table 6. Estimated Change in Students' Average Test/Exam Scores After Regular ICT Use (N = 50)
Question 5: By approximately how much have your students' average test/exam scores changed after you began using digital tools regularly?

Estimated Change in Average Scores	Frequency (n)	Percentage (%)
0–5% increase	9	18
6–10% increase	14	28
11–15% increase	8	16
More than 15% increase	5	10
No change / decline / not sure	14	28

Altogether, 72% of teachers reported some level of improvement in average scores, with the most common range being a 6–10% increase (28%), followed by 0–5% (18%) and 11–15% (16%). Ten per cent estimated improvements of more than 15%. Around 28% reported no clear change, a decline, or uncertainty. While these are self-reported estimates rather than experimentally derived effects, they suggest that regular digital tool usage is widely associated, in teachers' experience, with modest yet meaningful gains in students' academic performance.

4. Discussion

The study's findings indicate that secondary school teachers in Jharkhand who have undergone ICT-related teacher education are not only using digital tools frequently but also perceive them as beneficial for students' academic performance. These results resonate with international and national research demonstrating that, when thoughtfully integrated, ICT can enhance both teaching processes and learning outcomes (Msafri et al., 2023; Mishra & Koehler, 2006).

Frequency and Nature of ICT Use

The high proportion of teachers using digital tools several times per week contrasts with earlier global studies in which regular ICT use remained limited to a minority of teachers. Analyses from the IEA SITES 2006 study showed substantial cross-national variation, with many systems reporting relatively infrequent classroom use of ICT despite substantial infrastructure investments (Law et al., 2008). Likewise, Hennessy et al. (2005) found that, in many contexts, computers were used only sporadically, often for demonstration rather than ongoing instructional integration. Against this backdrop, the Jharkhand data suggest that for teachers who have access to ICT labs and ICT-related training, integration is moving beyond sporadic use toward routine practice, likely reflecting the effect of recent state-level investments and training initiatives (Parashar, 2019; India Today Education Desk, 2025). At the same time, the predominance of presentation software and videos as the most frequently used tools indicates a pattern commonly observed in other studies: teachers initially adopt ICT to support traditional, teacher-centred methods (slideshows, video explanations) before embracing more interactive, student-centred applications (Sharma, 2021; Msafri et al., 2023). From a TPACK perspective, this suggests that many teachers have acquired basic technological knowledge and some technological–pedagogical knowledge, but may still be developing the deeper TPACK required to redesign tasks, assessments and classroom roles in technology-rich ways (Mishra & Koehler, 2006; Koehler et al., 2013).

Self-Rated Integration and Teacher Perceptions

The self-ratings of ICT integration—half "moderate" and about one-third "high"—align with evidence that once a critical mass of infrastructure and professional development is in place, teachers increasingly view technology as a normal part of pedagogy rather than a novelty (Law et al., 2008; Sharma, 2021). Yet the 18% who report low integration echo findings from previous research that persistent concerns about time, curriculum demands, technical support and examination pressures can limit ICT use even in well-equipped settings (Hennessy et al., 2005; Abel et al., 2022). Teachers' largely positive perceptions of ICT's effect on academic performance are consistent with Abel et al.'s (2022) meta-ethnographic review, which found that teachers

often see technology as enhancing engagement, access to resources and opportunities for active learning, while still acknowledging logistical challenges. The Jharkhand teachers' views also align with Indian case studies where ICT-based lessons have been associated with improved understanding and test performance, particularly in science and mathematics (Sharma, 2021; Sahu, 2025).

Reported Effects on Academic Performance

Although the present study relies on teachers' estimates rather than objective pre- and post-test data, the reported gains—most frequently in the 6–15% range—are broadly comparable with effects observed in empirical research. Adebayo et al. (2024) found that students in technology-enhanced classrooms achieved significantly higher mean scores than those taught using traditional methods, attributing the difference to interactive materials and immediate feedback opportunities. Similarly, Sahu (2025) reported that integrating digital tools into secondary classroom practice in India led to notable improvements in engagement and academic performance, especially when teachers used apps, videos and quizzes to scaffold difficult concepts.

The convergence between teachers' perceptions in this study and the quantitative findings elsewhere strengthens the plausibility of the reported score gains. It suggests that increased exposure to visual and interactive explanations, more opportunities for practice, and the use of digital assessment tools may together underpin the observed improvements (Msafri et al., 2023; Sharma, 2021). Nonetheless, caution is warranted: self-report data are subject to recall and attribution biases, and improvements may also be influenced by other factors such as syllabus changes, coaching classes or changes in assessment difficulty.

Role of ICT-Oriented Teacher Education

The patterns observed are consistent with research that emphasizes the importance of ICT-rich teacher education. Tondeur et al. (2012) argue that teacher education programmes that model technology-enhanced pedagogy, provide authentic design tasks and build collaborative learning communities are more likely to produce teachers who integrate ICT meaningfully in their classrooms. In this study, all participants had completed ICT-oriented pre-service or in-service training, which likely contributed to their relatively high frequency of ICT use and confidence in its effectiveness. The TPACK framework provides a useful lens for interpreting these findings. Teachers who reported high levels of integration and larger performance gains may be those who have developed more robust TPACK, enabling them to select tools and design activities that align technology with content and pedagogy (Mishra & Koehler, 2006; Koehler et al., 2013). However, the dominance of presentation and video-based tools indicates that many teachers are still in earlier stages of this development, where technology primarily augments existing practices rather than fundamentally transforming them.

Jharkhand's ICT Context

Situating these results within Jharkhand's broader context is crucial. The state has rapidly expanded ICT labs and computer facilities, now reportedly exceeding national averages (Parashar, 2019; India Today Education Desk, 2025; Times News Network, 2025). The present findings suggest that, in schools where infrastructure is functional and teachers have received some ICT-related training, this investment is beginning to translate into everyday classroom practice and perceived academic benefits. Moreover, broader Indian evidence highlights ongoing challenges in connectivity, electricity reliability and technical support, especially in rural schools (Sharma, 2021). The 18% of respondents who report low integration and the 28% who see no clear performance gains or are unsure may be concentrated in contexts where these barriers remain acute or where assessment pressures discourage experimentation with new pedagogies.

Limitations and Directions for Future Research

Several limitations of the study must be acknowledged. The sample is small (N = 50) and limited to schools with ICT infrastructure and trained teachers, which restricts generalizability. The use of self-reported perceptions and estimated score changes precludes causal inferences and may over- or under-estimate actual effects. The study did not disaggregate results by subject, nor did it collect detailed qualitative data on specific pedagogical strategies, which are known to strongly influence ICT's impact (Law et al., 2008; Msafri et al., 2023).

Future research could adopt mixed-method designs that combine classroom observations, student achievement data and interviews with teachers and students to provide a richer picture of how ICT-related teacher education translates into actual practices and outcomes in Jharkhand. Longitudinal work following cohorts of teachers from their pre-service programmes into their early career could illuminate how TPACK develops over time and under what conditions it leads to sustained, high-quality ICT integration (Tondeur et al., 2012; Koehler et al., 2013). Comparative studies across states or between government and private sectors would also be valuable for identifying policy and institutional levers that most effectively support ICT integration in teacher education and secondary schooling.

5.Conclusion

This analytical study of 50 secondary school teachers in Jharkhand suggests that integrating ICT into teacher education is associated with frequent digital tool usage in classrooms and perceived improvements in students' academic performance, commonly in the range of 6–15% gains in average scores. Teachers predominantly use presentation software and educational

videos, and most rate their level of ICT integration as moderate or high, though a minority still report low usage and no clear impact on achievement.

The findings support the view that ICT-oriented teacher education, framed by models such as TPACK and reinforced through ongoing professional development, can help move teachers beyond basic computer literacy toward meaningful classroom integration. For Jharkhand, the results highlight the importance of extending sustained, practice-focused ICT training to more teachers, encouraging more interactive and student-centred uses of digital tools, and addressing infrastructural and support challenges in rural and under-resourced schools. Addressing these priorities can help ensure that substantial investments in digital infrastructure and teacher education translate into deeper, more equitable improvements in secondary students' academic performance across the state.

References

Abel, V. R., Tondeur, J., & Sang, G. (2022). Teacher perceptions about ICT integration into classroom instruction. *Education Sciences, 12*(9), 609.

Adebayo, O. D., Chen, M., Onwuzuruike, O. L., & Joshua, A. (2024). The impact of ICT integration on academic performance: A comparative study of traditional and technology-enhanced classrooms. *International Journal of Trend in Scientific Research and Development, 8*(6), 1132–1141.

Hennessy, S., Ruthven, K., & Brindley, S. (2005). Teacher perspectives on integrating ICT into subject teaching: Commitment, constraints, caution, and change. *Journal of Curriculum Studies, 37*(2), 155–192.

India Today Education Desk. (2025, November 7). *76% Jharkhand schools now have computer labs, above national average of 63%*. India Today.

Koehler, M. J., Mishra, P., Kereluik, K., Shin, T. S., & Graham, C. R. (2013). The technological pedagogical content knowledge framework for teachers and teacher educators. In J. M. Spector et al. (Eds.), *Handbook of research on educational communications and technology* (pp. 101–111). Springer.

Kozma, R. B. (2010). ICT policies and educational transformation. *UNESCO Policy Brief on ICT in Education, 2*, 1–4.

Law, N., Pelgrum, W. J., & Plomp, T. (Eds.). (2008). *Pedagogy and ICT use in schools around the world: Findings from the IEA SITES 2006 study*. Springer.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054.

Msafri, M. M., Kangwa, D., & Cai, L. (2023). A systematic literature review of ICT integration in secondary education: What works, what does not, and what next? *Discover Education, 2*, 44.

NCERT. (2025). *State report: Jharkhand*. PARAKH – National Assessment Centre.

Parashar, D. (2019). Integration of ICT in schools: A comparative analysis of Jharkhand and national averages. *International Journal of Innovative Research in Engineering & Multidisciplinary Physical Sciences, 7*(4), 1–8.

Sahu, A. (2025). Integrating digital tools in secondary education: A study on student engagement and academic performance. *The Progress Journals, 3*(1), 15–21.

Sharma, A. (2021). *Impact of ICT on teaching practices in India* (ICT India Project Working Paper No. 46). Center for Sustainable Development, Columbia University.

Times News Network. (2025, November 6). *Jharkhand's digital education transformation: 33,718 schools now equipped with ICT labs*. *The Times of India*.

Tondeur, J. (2018). Enhancing future teachers' competencies for technology integration in education: Turning theory into practice. *Seminar.net, 14*(2), 217–232.

Tondeur, J., van Braak, J., Sang, G., Voogt, J., Fisser, P., & Ottenbreit-Leftwich, A. (2012). Preparing pre-service teachers to integrate technology in education: A synthesis of qualitative evidence. *Computers & Education, 59*(1), 134–144.