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ROLE OF ICT IN ENHANCING RESEARCH SKILLS IN TEACHER EDUCATION: A SYSTEMATIC REVIEW

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Abstract

Information and Communication Technologies (ICT) have transitioned from optional digital add-ons to foundational research infrastructure in teacher education. This expanded review synthesizes frameworks (TPACK, SAMR, DigCompEdu, UNESCO ICT-CFT), policies (NEP-2020), and platform ecosystems (IRINS, Shodhganga, OSF, ORCID) to explain how ICT enriches each phase of the research cycle for pre-service and in-service teacher educators: problem scoping, literature discovery and appraisal, research design and ethics, fieldwork, mixed-methods analysis, scholarly writing, open dissemination, identity/impact management, and research integrity. Drawing on international guidance and India-specific developments (e.g., UGC-INFLIBNET services), we propose a competency-aligned integration model for teacher education institutions (TEIs) and discuss persistent constraints (infrastructure, capacity-building, language/accessibility, and assessment cultures). The review concludes that ICT produces durable research skills when embedded within coherent curricula, robust institutional infrastructures, and integrity-first cultures rather than as isolated tool training. (Mishra & Koehler, 2006; Redecker, 2017; UNESCO, 2023/2018; Government of India, 2020; Romrell, Kidder, & Wood, 2014).

Keywords: *ICT; teacher education; research skills; TPACK; SAMR; DigCompEdu; UNESCO ICT-CFT; NEP 2020; open science; OSF; ORCID; IRINS; Shodhganga; academic integrity.*

1. Introduction

Teacher education increasingly positions research not as a capstone requirement but as a professional habit that informs classroom decision-making, programme evaluation, and system improvement. ICT accelerates this shift by lowering the costs of discovery (digital libraries), improving rigor and transparency (data/analysis tools, preregistration), and expanding dissemination and recognition (open repositories and persistent identifiers). The European Commission's DigCompEdu frames educator digital competence across six domains and 22 competencies including professional engagement, digital resources, teaching/assessment, and empowering learners competencies that overlap directly with research literacies such as information evaluation, data stewardship, methodology, and scholarly communication (Redecker, 2017).

In India, NEP-2020 explicitly centres research culture, academic integrity, and technology integration, linking teacher preparation to twenty-first-century competencies and establishing enabling initiatives like “One Nation, One Subscription” and UGC-INFLIBNET infrastructures for research information and dissertations (e.g., IRINS, Shodhganga). These policy and infrastructural shifts create unusual opportunities for TEIs to embed ICT-enabled research training from the B.Ed. through M.Ed. and continuing professional development (Government of India, 2020; IRINS & Shodhganga portals).

2. Method and Scope of the Review

This narrative systematic review draws on (a) conceptual frameworks (TPACK, SAMR, DigCompEdu, UNESCO ICT-CFT); (b) policy documents (NEP-2020 and official implementation notes); and (c) scholarly/authoritative sources on open science, research integrity, and research infrastructure (OSF, ORCID, IRINS, Shodhganga), prioritising 2014–2025 literature to reflect the consolidation of these frameworks and India-specific reforms. Searches were conducted across official portals (UNESCO, European Commission/JRC), policy repositories (Ministry of Education NEP-2020), and peer-reviewed outlets (Online Learning Journal; Information Processing & Management; PubMed Central) using controlled terms (e.g., “teacher education AND research skills AND

ICT,” “DigCompEdu,” “ICT-CFT,” “open science training,” “IRINS,” “Shodhganga”). Inclusion emphasised authoritative and citable sources; where implementation facts required currency (e.g., IRINS roll-outs), we reference official IRINS pages and reputable news coverage.

3. Conceptual and Theoretical Foundations

3.1 ICT, research skills, and educator competence

ICT comprises devices, networks, and applications that support scholarly workflows. Research skills here include problem formulation, literature search and critical appraisal, ethics and design, quantitative/qualitative/mixed-methods analysis, academic writing, dissemination, and impact tracking. DigCompEdu situates these competences within educator practice (e.g., “digital resources,” “assessment,” “professional engagement”), while UNESCO's ICT-CFT provides progression and policy alignment for teacher development. Together, these frameworks argue that digital competence and research literacy are entwined professional capacities for educators. (Redecker, 2017; UNESCO, 2023/2018).

3.2 TPACK and the epistemic role of technology in research

TPACK extends Shulman's PCK by theorising how technology knowledge intersects with content and pedagogy; although teaching-oriented, the framework's integrative logic is equally instructive for research: technology shapes what counts as feasible methods (e.g., LMS analytics), changes data representation (interactive visualisations), and redefines dissemination (preprints, OA repositories). Thus, research competence emerges at the nexus of methodological content knowledge and technological fluency (Mishra & Koehler, 2006).

3.3 SAMR and depth of digital integration

The SAMR model distinguishes substitution/augmentation from modification/redefinition, a lens that is useful for research training: typing references is substitution; collaborative, version-controlled reviews with reproducible search logs and shared codebooks approach redefinition. Programmes that target the “transform” levels tend to produce

durable gains in research independence (Romrell, Kidder, & Wood, 2014; Blundell et al., 2022).

4. ICT Across the Research Cycle in Teacher Education

4.1 Topic scoping, discovery, and literature synthesis

Federated scholarly search (ERIC, Scopus, Google Scholar) and national infrastructures enable efficient scoping. In India, Shodhganga's open theses corpus and advanced search functions provide local methodologies, instruments, and problem framings that are crucial for teacher-education contexts (e.g., school placement constraints, multilingual settings). Training should emphasise advanced query design, alerts, and protocolised screening (PRISMA-like) using reference managers for de-duplication and coding. Shodhganga's scale and open access make it a uniquely powerful support for M.Ed./B.Ed. reviews and supervisor guidance. (Shodhganga portal & overview).

Reference managers (Zotero/Mendeley) are not merely citation tools but *knowledge organisation systems*: they capture metadata, support PDF annotation, and export structured bibliographies (APA) across cloud-based writing environments. Empirical work and professional guidance consistently recommend institutional training in these tools early in teacher-education research methods courses to reduce citation errors and to scaffold rigorous reviewing. (Representative studies and guides).

4.2 Research design, ethics, and preregistration

ICT now scaffolds design transparency and ethical compliance. The Open Science Framework (OSF) supports preregistration, protocol and material sharing, permissions management, and DOI-bearing project components; such structured openness reduces p-hacking risks, increases replicability, and makes supervision more efficient (Foster & Deardorff, 2017; OSF product pages). Ethics education can be embedded through templated DMPs (data-management plans), consent form repositories, and versioned SOPs accessible to student cohorts.

4.3 Data collection in authentic school settings

Digital instruments secure web surveys, mobile forms, audio/video capture, and LMS event logs enable scalable, time-stamped field data under

realistic school constraints (e.g., limited contact time). For qualitative work, NVivo/ATLAS.ti assist in systematic coding of interviews, lesson plans, and artefacts; for classroom studies, LMS exports (attendance, submissions, timestamps) provide ready-to-analyse logs. Guidance literature shows these tools increase efficiency and enable higher-order analyses when paired with methodological mentoring (Dhakal, 2022; Edwards-Jones, 2014).

4.4 Data stewardship, analysis, and reproducibility

ICT underpins good research data practice: structured directories, README files, codebooks, anonymisation pipelines, and controlled access. Quantitative analysis can be conducted in R/PSPP/SPSS; qualitative analysis in NVivo; mixed-methods projects benefit from triangulation features (e.g., matrix queries). Beyond "button knowledge," TEIs should teach reproducible workflows (scripted analyses, version control, OSF component linking) to form durable habits and facilitate supervisor feedback. Evidence from qualitative-methods education and open-science training underscores these payoffs (Dhakal, 2022; Foster & Deardorff, 2017; OSF training resources).

4.5 Academic writing, referencing, and collaborative authoring

Cloud-based writing (Google Docs, Overleaf) enables tracked revisions, structured templates (APA), and seamless integration with reference managers; combined with IRINS-enabled faculty guidance, these tools standardise expectations for citations, ethics statements, and data availability. Overleaf/LaTeX is especially useful for quantitative and psychometric studies requiring equations and numbered environments; Docs is effective for collaborative qualitative manuscripts with heavy commenting cycles. (IRINS portal; DigCompEdu guidance on professional engagement).

4.6 Researcher identity, visibility, and impact

Persistent identifiers (ORCID iDs) disambiguate names, automate profile updates via publisher integrations, and link outputs to affiliations and grants critical for early-career teacher educators. Institutions increasingly integrate ORCID with IRINS to auto-populate faculty and student-researcher profiles and to monitor outputs for QA and mentoring. Official ORCID guidance and

IRINS documentation emphasise time-saving and data-quality benefits. (ORCID; IRINS official pages).

4.7 Integrity, originality, and responsible use of detection tools

Similarity-checking systems (e.g., Turnitin) are widely used to *educate* writers about citation and paraphrasing and to *screen* submissions. Authoritative reviews emphasise that a “similarity index” is not equivalent to a plagiarism verdict; interpretation requires disciplinary judgment and formative feedback. Integrity instruction (citations, paraphrasing, use of quotation, and data re-use norms) should accompany any use of detection software in TEIs. (Meo & Talha, 2019).

5. Evidence of ICT’s Impact on Research Skills in Teacher Education

Syntheses of digital integration show that technology improves outcomes when embedded in coherent pedagogical designs and authentic tasks *not* when taught as isolated tool demonstrations. In higher education and teacher-education contexts, SAMR-informed designs that move into “modification/redefinition” (e.g., reproducible projects with open materials, collaborative coding frameworks, and transparent peer feedback) strengthen students’ perceived and demonstrated research competences. Scoping reviews likewise show SAMR’s value in classifying practice for reflective improvement (Romrell et al., 2014; Blundell et al., 2022).

Open-science training programmes report improved understanding of provenance, licensing, and replication when learners use platforms like OSF for preregistration and project structuring effects that translate well into teacher-education research courses where many projects are small-N, mixed-methods, and context-bound (Foster & Deardorff, 2017; Casimo et al., 2023).

Institutionally, IRINS-style Research Information Management (RIM) systems consolidate outputs, enable mentoring and benchmarking, and support integrity norms through visibility and accountability. As Indian universities adopt IRINS, news coverage and official documentation point to its role in profile curation, analytics, and alignment with NEP-2020 research mandates benefits that indirectly enhance research skills by clarifying exemplars and expectations. (IRINS official; recent IRINS events/news).

6. Policy and Institutional Contexts (India Focus)

NEP-2020 articulates technology integration and research culture as core to teacher preparation, calling for robust professional standards (e.g., NPST) and digital infrastructure for resources, assessment, and research. These priorities align closely with UNESCO’s ICT-CFT, which offers adaptable, role-linked competencies and objectives for pre- and in-service teacher training. TEIs can thus localise DigCompEdu’s competence language and ICT-CFT’s progression expectations to create staged research-skills curricula. (Government of India, 2020; UNESCO ICT-CFT 2023/2018; DigCompEdu).

UGC–INFLIBNET infrastructures Shodhganga (ETD repository) and IRINS (RIM) together with access initiatives (e.g., ONOS as reported) create a uniquely enabling ecosystem for teacher-education research: open exemplars (theses), identity/impact infrastructure (IRINS + ORCID), and broader access to paywalled literature via national negotiation. (Shodhganga portal; IRINS brochure/pages; reputable news items on IRINS/ONOS).

7. Persistent Challenges and Equity Considerations

Infrastructure and access. Bandwidth/device constraints in rural TEIs limit participation in collaborative and data-intensive workflows, making offline-first designs and low-bandwidth tools necessary. **Capacity-building.** Many professional-development efforts prioritise tool operation over epistemic use (design, validity/credibility, argumentation), which weakens transfer to independent research. **Language and accessibility.** Multilingual realities in Indian schools complicate search, consent, and analysis; structured glossaries, translated instruments, and accessibility support are needed. **Assessment culture.** When speed and counts are over-valued, careful, reproducible research suffers; institutions should align recognition with quality and openness. These concerns mirror international reviews that warn against “technology first” approaches and stress mentoring and assessment alignment. (Blundell et al., 2022).

Integrity and AI-era issues. Similarity systems must be framed pedagogically and interpreted professionally; AI-assisted writing and analysis

require transparent acknowledgement and adherence to journal/institutional policies. Integrity instruction should foreground judgment, citation practice, data ethics, and *process* documentation over mere “scores.” (Meo & Talha, 2019; UNESCO ICT-CFT guidance on policy alignment).

8. A Competency-Aligned Integration Model for TEIs

8.1 Curriculum design (programme level)

Map research competencies across semesters using DigCompEdu and ICT-CFT as the spine:

Year 1 information literacy, scholarly search strategies, reference management, and ethical use; **Year 2** design and DMPs, preregistration on OSF, qualitative/quantitative foundations; **Advanced semesters** mixed-methods analysis, reproducible workflows (scripts, versioning), APA-conformant writing, and open dissemination (IRINS-linked deposits). SAMR targets should move typical course tasks from substitution (typing) to modification/redefinition (collaborative, open, reproducible studies). (Redecker, 2017; UNESCO ICT-CFT; Romrell et al., 2014).

8.2 Learning design (course level: Research Methods I/II)

Require students to (a) register ORCID iDs and connect them to IRINS instances; (b) build shared bibliographies with Zotero/Mendeley; (c) pre-register on OSF; (d) collect data through secure mobile or LMS-based tools; (e) analyse with NVivo/SPSS/R using transparent, archived scripts/codebooks; (f) write collaboratively in Overleaf/Docs with APA templates; and (g) deposit de-identified materials and final reports in an institutional repository. Evidence shows that such authentic, open-workflow assignments improve process knowledge and reduce integrity risks. (ORCID; OSF; Dhakal, 2022; Foster & Deardorff, 2017).

8.3 Institutional infrastructure and culture

Provide campus-wide IRINS onboarding and ORCID integration; define research data policies with storage and sharing guidance; deploy Shodhganga-aligned ETD workflows; run librarian-led clinics co-taught with methodologists; and align promotion/recognition with open, high-integrity scholarship (e.g., preregistration badges, open dataset DOIs).

Indian institutions increasingly report benefits of IRINS for profile curation, benchmarking, and mentoring visibility conditions that foster research skill development. (IRINS official pages and events).

9. Future Directions

Learning analytics and school-based datasets.

As LMSs and school information systems mature, teacher-education research can leverage ethically-governed, de-identified event data to study pedagogy at scale. **Open science mainstreaming.** OSF-style workflows and repository mandates will normalise transparency, improving thesis supervision and replication. **Responsible AI.** UNESCO’s competence frameworks and emerging AI guidance (aligned with ICT-CFT) will shape responsible use for literature triage, coding assistance, and language refinement always with disclosure and human adjudication. **National access initiatives.** India’s negotiations for national access (as reported) plus IRINS scale-up will expand literature availability and amplify teacher-education research visibility. (UNESCO ICT-CFT; Foster & Deardorff, 2017; IRINS news).

10. Conclusion

ICT now constitutes the research substrate of teacher education. When institutions anchor training in robust competence frameworks (DigCompEdu; ICT-CFT) and scaffold authentic, open workflows (OSF, IRINS, ORCID, Shodhganga), pre-service and in-service teachers gain durable research capacities: rigorous literature synthesis, ethical design, mixed-methods analysis, collaborative writing, open dissemination, and integrity-first identity management. The decisive variable is not tool availability but programme design, mentoring, and institutional culture. For India and similar settings, policy momentum (NEP-2020) and national infrastructures (UGC-INFLIBNET) offer rare leverage to make ICT-mediated research the norm provided TEIs move beyond substitution to transformative practice. (Government of India, 2020; Redecker, 2017; UNESCO ICT-CFT; Mishra & Koehler, 2006; Romrell et al., 2014).

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