Omniscient
(An International Multidisciplinary Peer-Reviewed Journal)
Vol 3 Issue 1 Jan-Mar 2025 EISSN : 2583-7575

Innovative Pathways in Teacher Education: A New Era of ICT Integration and Digital Literacy

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Abstract

The concept of technology is familiar in education. It has been kept in consideration earlier also, formerly in classrooms in the form of audio devices, later on, computer-assisted instruction used in teaching, and now there has been an innovative and drastic paradigm shift observed in the field of education sector in the form of disruptive digital technologies like AI, Machine Learning, Robotics based, Gamification, AR and VR along with blended and flipped mode of pedagogy approaches. Nowadays, technology plays a pivotal role in the education system. Suppose we want to deliver quality education to the youth who will be the future of tomorrow's world. In that case, we must improve our standard of teacher education—ensuring better access, equity, and quality—to promote digital literacy by including technology. Technology assists our teachers, and with its help, our educators will actively implement the concept of inclusivity. Technology helps to integrate the students by providing a collaborative and engaging environment that includes digital pedagogy. This article aims to give an overview to guarantee that everyone receives an inclusive education. It also offers an in-depth analysis of technology's use in teacher education. It does this by resolving issues and expanding the reach of current online resources and ICT-based educational initiatives. The study carried out in this article looked into the goals that technological innovations can achieve in the arena of instructor education and the suggestions that the National Education Policy 2020 offered for integrating technological advances into the classroom by adopting digital technology. It also emphasizes the difficulties in putting NEP 2020's suggestions about using technology in the classroom into practice by the teacher educator. The study is qualitative, with the document analysis and data collected from various sources to be analyzed.

Keywords: *Teacher Education, Technology Integration, Digital Literacy, ICT, NEP 2020.*

Introduction

As we move from a national to a global educational system, worldwide education impacts the national education system in every way. India's educational system has undergone several vibrant expansion eras, from the Veda to the after-independence era. Renowned Indian philosophers have strongly emphasized helping people realize their true potential by considering what makes each person unique (Bisht, 2013). The primary objective of the twenty-first century is to increase aspirations in society. Still, it also requires wisdom investigation, conversation resolution, technological advances, the integration of science across all aspects of life, and most importantly, the establishment of suitable mindsets in our younger generation (Kamari & Poonam, 2022). The use of ICT in educational settings increases the amount of understanding and knowledge shared

with learners. It also allows for the incorporation of novel perspectives and competencies for students and instructors (Dodmani,2020).

Very few schools use current communicative mediums conceptually for teacher preparation. The trainers equipped teacher trainees to embrace modern technologies and foster more interactive learning environments, as these tools empower educators and learners to take greater control over instruction. One of the strongest arguments for incorporating information and communication technologies in teacher education is their potential to transform teaching and learning (Bisht, 2013). The explosion of information and communication technologies presents an enormous opportunity for professional growth for educators because teachers must possess the necessary technical skills to effectively utilize ICT successfully and to instruct and coach students in its purposeful use. Teachers must gain the pedagogical knowledge to collaborate effectively in a technologically enabled instructional setting (Dhingra & Rahman, 2014)." Instructors must be encouraged to make decisions about their ICT development needs continuously, ensuring more involvement and integration of ICT within the teaching and learning process. Opportunities for professional development must be continuously available for instructors to continue improving their computer knowledge, skills, and attitudes" (Alemu, 2015). Merely acquiring basic digital skills is not enough. Educators must design teacher education programs with a clear purpose: to cultivate digital instructional competencies. These include fostering ICT mindsets, building proficiency in information and communication technologies, enhancing data literacy, and developing a critical awareness of both the advantages and the challenges of integrating technology into classroom practice. Teachers with strong digital competencies are better equipped to integrate technology into their daily teaching practices (Kaminskienė et al., 2022). Only well-prepared teachers can effectively meet learners' evolving needs by adopting various technological advancements to enhance digital literacy.

The need and significance of the Study in Teacher Education program with the help of ICT Integration.

Technology has completely changed our society, and educational endeavors at the academic level have yet to keep pace with this technological advancement. The teacher imparts instruction in our educational setting in an old-fashioned, teacher-centric manner that is frequently dull and fails to pique students' interests. However, student-centric education is the norm in the twenty-first century. Because students absorb knowledge from various sources, using technology and

multimedia in the classroom is crucial, and teachers must also be proficient in these areas. The current study is critical and necessary since it demonstrates ICT teachers' educational functions.

Review of Related Literature

Karunakaran and Dhanawardana (2023) study focuses on assessing the problems and issues faced by social science teachers in the teaching-learning process. Researchers conducted the study in the three education zones of Sri Lanka by conducting online interviews with twenty-four social science teachers who taught junior secondary classes. Researchers found the problems of (i) accessing ICT resources, as access to ICT resources was a problem that teachers experienced; (ii) skill development in the ICT teachers lamented a problem relating to their skill development in the ICT area; (iii) availability of resources, in terms of disparities being evident among schools about the availability of resources in the ICT area; and (iv) quality ICT infrastructure, since disparities were evident in the quality of ICT infrastructure available among schools. The study recommends the necessary steps by education policymakers and other pertinent individuals to address this issue within the school system.

Kaminskienė, Järvelä and Lehtinen (2022) study deals with a challenge and a call regarding teachers' digital skills and technology integration into educational content and processes. It raises questions regarding how technologies have produced new skill gaps in pre-service and in-service teacher training and how that has affected traditional teacher education. This way, we discuss what interventions apply to different contexts to address such challenges. Educators should consider technology as a field in which they develop and apply new competencies to create learning environments for teacher-students.

Alemu (2015) investigated the challenges and promises made for teaching learning practices by integrating ICT into teacher education programs. The researcher tries to enhance instructors' competencies through pre-service and in-service education by imbuing ICTs as pedagogical tools for identifying Adama University instructors using different teaching-learning environments. The researchers followed a mixed-method research design and gathered data through observation, individual interviews, and questionnaires from the school's instructors, deans, and departments selected for the study. The findings revealed a positive attitude toward integrating digital technology into the educational system.

Ghavifekr, Kunjappan, Ramasamy, and Anthony (2016) study the Issues that challenge ICT integration. The study used a quantitative research method in Melaka, Malaysia. Data was

collected randomly from 100 secondary school teachers in the state. The researcher found the key issues and challenges significant in teachers' use of ICT tools were less available with less network connections, a lack of technical support and practical training, limited time to practice the technology to get familiar with it, and a lack of teachers' competency. Researchers found that male teachers use ICT tools more than female teachers in classroom practices.

Objectives of the Study

1. To study the different technology theoretical frameworks served by technology Integration in Teacher Education.
2. To find out the various provisions for ICT integration in teacher education.
3. To find out the challenges to implementing NEP 2020 in integrating Technology in Teacher Education to improve digital literacy.
4. To study the recommendations and suggestions of NEP 2020 for effective implementation of ICT integration in teacher education to enhance digital literacy.

Research Methodology

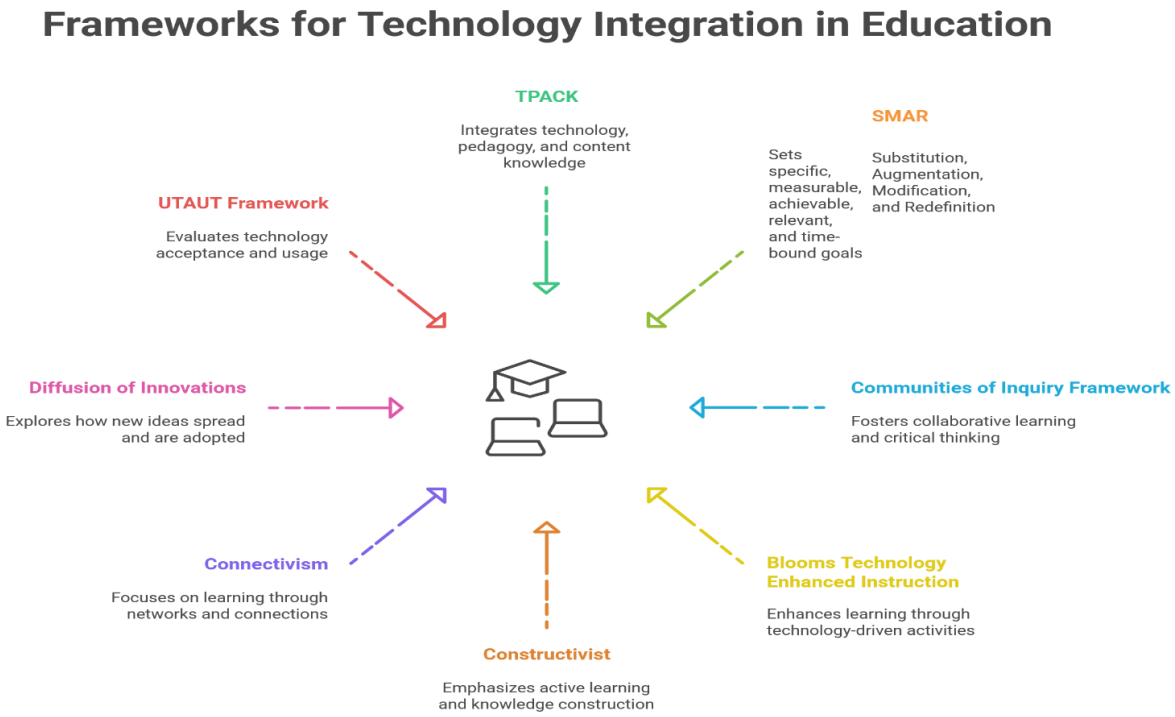
This study adopts a qualitative method using document and thematic analysis. The researcher collected data from primary sources such as NCF 2005 and the NEP 2020 policy document, and secondary sources including websites, magazines, journals, newspapers, and available e-content. The researcher selected data using databases like Google Scholar, ResearchGate, and official government websites (MOE, NCERT, NCTE, UGC, My Gov for Digital India), applying search strings related to topic keywords. The search was limited to social science subject areas, article document types, English language publications, and journal articles as source types. After reviewing the remaining papers, on such criteria, the researcher removed duplicates and selected 37 articles and eight government reports to meet the study's inclusion criteria for the final review. Drawing on Adam's (2015) and Bloom's (1956) frameworks, a classification or tiering of documents (e.g., policy-level, institutional-level, practitioner-level) would have clarified the cognitive depth and scope of analysis. Employing a structured framework, such as TPACK or SAMR, allowed for identifying levels of ICT integration and pedagogical alignment, offering analytic rigor. Figure generated using Napkin AI based on original text content created by the researcher.

Objective-wise discussion

Objective 1: To study the different technology theoretical frameworks served by technology Integration in Teacher Education.

Theoretical Framework of Technology Integration

- Mishra and Koehler (2006) created the **framework known as TPACK,** which places a priority on when teachers can combine the domains of technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) in order to develop engaging experiences for learners, they are integrating technology effectively, Modiba (2024). To enhance learning, TPACK holds that educators must comprehend how technology integrates with pedagogy and subject matter (Mishra & Koehler, 2006). This incorporation ensures that technological innovation is an integral part of education rather than just an add-on (Voogt & McKenney, 2017).
- **SAMR(Substitution, Augmentation, Modification, and Redefinition**) (Puentedura,2006) The approach urges teachers to go beyond mere substitutions to accomplish transformational applications utilizing technology that drastically change instructional tasks. It also functions as a tool for measuring the degree of incorporation of Technology (Hamilton et al., 2016).
- In online and blended educational settings, where technology-mediated interactions serve an essential role in encouraging cooperative and reflective instruction, the **Communities of Inquiry Framework** developed by Garrison, Anderson, and Archer (2000) demonstrates the three critical components for developing effective educational surroundings: Social Presence, The cognitive domains Presence, and Instruction Presence highlights the significance of designing effective technological connections that facilitate an immersive educational experience (Garrison et al., 2001).



- Intellectual skills are categorized into hierarchy stages according to **Bloom's classification** (1956): Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. Technology can assist with these cognitive procedures by offering resources that improve the ability to think critically and solve problems (Bloom, 1956). Teachers can create technology-enhanced instruction methods that target different cognitive levels by using this classification as a point of reference(Adams, 2015)
- According to **the constructivist theory of Piaget (1973) and Vygotsky** (1978), students build their cognition via connections to their surroundings. The constructivist theory views technology as a tool that facilitates experiments, inquiry, and solving problems, enabling students to take part in building their understandings (Piaget, 1973; Vygotsky, 1978). The theory behind this method emphasizes how technological advances might support student-focused, interactive, and experiential learning (R. Sharma, 2023).
- Siemens first proposed **connectivism in 2005**. He outlined how to understand education in the age of technology. According to him, learning is navigating and communicating in those networks, emphasizing networking and digital connections as the route toward constructing

understanding. Due to their continuously changing and spreading nature, these links facilitate the spread nature of information and become possible and sustainable mainly through technologies (Siemens, 2005).

- **Venkatesh, Morris, Davis, and Davis (2003)** developed the **UTAUT framework**, which looks at four primary constructs: social influence, performance expectancy, effort expectancy, and enabling conditions. This model looks at how users embrace technology. This theory offers insights into overcoming obstacles and improving technology use by identifying variables that affect the adoption and successful application of technological innovations in education (Venkatesh et al., 2003).
- **Diffusion of Innovations:** This theory directs tactics for efficient execution and aids in understanding the elements influencing the acceptance of technology in educational contexts (Rogers, 2003) & (Sahin, 2006)

Objective 2: Provisions for ICT Integration and Technology Pedagogies in Teacher Education Programme in India

Various commissions and committees in national plans and programs have occasionally recognized the integration of ICT in teacher education programs and acknowledged the incorporation of technology in educators' training. To make education as prescribed by National Curriculum Framework 2005 principles to bring flexibility in assessment, following a constructivist approach, learning without burden, holistic development, and out-of-the-classroom learning to keep this teacher education needs to instruct and empower the educator to differentiate between the damaging use of ICT and the beneficial, dynamically appropriate utilization of ICT (*NCf 2005-English.Pdf*). The National Focus Group on Educational Technology (2006) recommended that multimedia and technology-driven education be incorporated into pre-service teacher preparation programs so that they become a natural part of the process of learning and instruction (p. 15). It also recommended proficiency in ICT for administrators, heads of schools, and other educational officials, in addition to teachers (Research & Ncert, 2015). In order to design NCFTE, 2009 NCERT organized two-week orientation programs for educators of teachers and used information technology and IT-based learning resources in partnership with NCTE, which is a step toward integrating information and communication technology in the curriculum for teacher preparation in schools. (Giri, 2022). National Knowledge Commission ensures the availability of additional resources, like broadband and communication capabilities and PCs. It also fully utilizes

technological advances in computer-based learning, and educators and other staff must receive training (Kundu, 2021). The Government of India spearheaded educational initiatives under Digital Mission 2015 through the Ministry of Education to empower teachers with the skills needed for a technology-driven classroom. Launched via the National Mission on Education through Information and Communication Technology (NMEICT), these Digital India programs aim to equip educators with the digital competence required for 21st-century teaching (Kennedy & Thangiah, 2020).ICT can be creatively used to promote pre-service and in-service educators' intellectual and professional growth (NCFTE, 2009) &(Singh, 2020). The Rashtriya Madhyamik Shiksha Abhiyan (RMSA, 2009) and the Sarva Shiksha Abhiyan (SSA,2000) have primarily incorporated ICTs in secondary education.

Objective 3: Integration of innovative practices involved in teacher education programs in the context of the National Education Policy to improve Digital Literacy

- National education policy is the major reform in education, especially for the teacher education program, and it is working on the significant aspect of Bhartiya Gayan Parampara NEP's emphasis on developing e-content in the regional languages. NETF (National Education Technological Forum), NEP paragraph 23.3 paved the way for digital technology Integration by building intellectual and Institutional capacities in Education Technology. (Ghosh, 2023).
- NEP 2020 states that efficient ICT tools will be provided to educators at institutions so they can successfully incorporate e-content into their lesson plans.
- In order to deliver standardized training programs to plenty of educators in a brief period, the National Education Policy 2020 proposes that using technological platforms like SWAYAM/DIKSHA for digital training for educators would be promoted.
- Innovations in technology for streamlining education planning, executives, and handling include procedures linked to enrollment, attendance, evaluation, etc.; encouraging teacher training and professional growth; improving educational access, and strengthening instruction, learning, and assessment processes. (NEP,2020; Para 23.5)
- NEP 2020 states that instructors will receive extensive instruction in learner-centric pedagogy and how to use online instructional tools and techniques to become proficient online content developers. The importance of the teacher in encouraging students to engage with the material and with one another actively will be emphasized. (Giri, 2022)

Purpose of Technology Integration for Teacher Education

The teaching profession now offers more options due to revolutionary technological breakthroughs in the last few decades. However, educators must also develop themselves to use these resources. **(Tenkorang, 2011) (Robinson & Latchem, 2003).**

- Technology helps teachers prepare for the classroom, and educators teach pre-service teachers ICT through various methods and strategies. They use applications like Kahoot, Google Classroom, databases, spreadsheets, and word processors. These technologies assist teachers in delivering hands-on instruction.**(Kamari & Poonam, 2022)**
- The University Grant Commission (UGC) has recommended that teachers complete online ongoing professional development (CPD) through simulated situation training on refresher orientation and Android refresher courses via video conferencing and online. This approach promotes ongoing professional growth. **(Kumar, Sunil,2020)**
- ICT-based instruction and learning initiatives can help educators conquer feelings of isolation by bringing them outside the educational setting and establishing connections with peers, mentors, curriculum specialists, and the larger worldwide teacher community **(Bisht, 2013).**
- Technology integration in teacher education programs helps support multiple learning styles for learners.
- Assistance for educators in pursuing ongoing professional growth and imparting knowledge at the learner's pace.

Thematic analysis towards integrating ICT in teacher Education aligns with Education Technology Frameworks.

Three broad themes will be identified based on the literature review. The first central theme is under Institutional and structural foundations; subthemes were (Teacher training, Resource constraints Higher Education, Learner education, and ICT Policy Integration) that mapped with the TPACK Framework and reflect the contextual knowledge (CK PK, TK) teachers must gain in pre-service education—also links to the "Knowledge Domains" of the TPACK model.

The second central theme was Digital Pedagogies and Competencies that relate to subthemes (Digital competencies, digital divide, education technology, technology integration, online education, and e-learning), mapped with **Dig Comp Edu SAMR framework** focusing on teachers' digital skills, tools used, and pedagogical application and **SAMR** Technology used to **augment** or

transform teaching practice—terms like "e-learning" map to **Modification** or **Redefinition** stages.

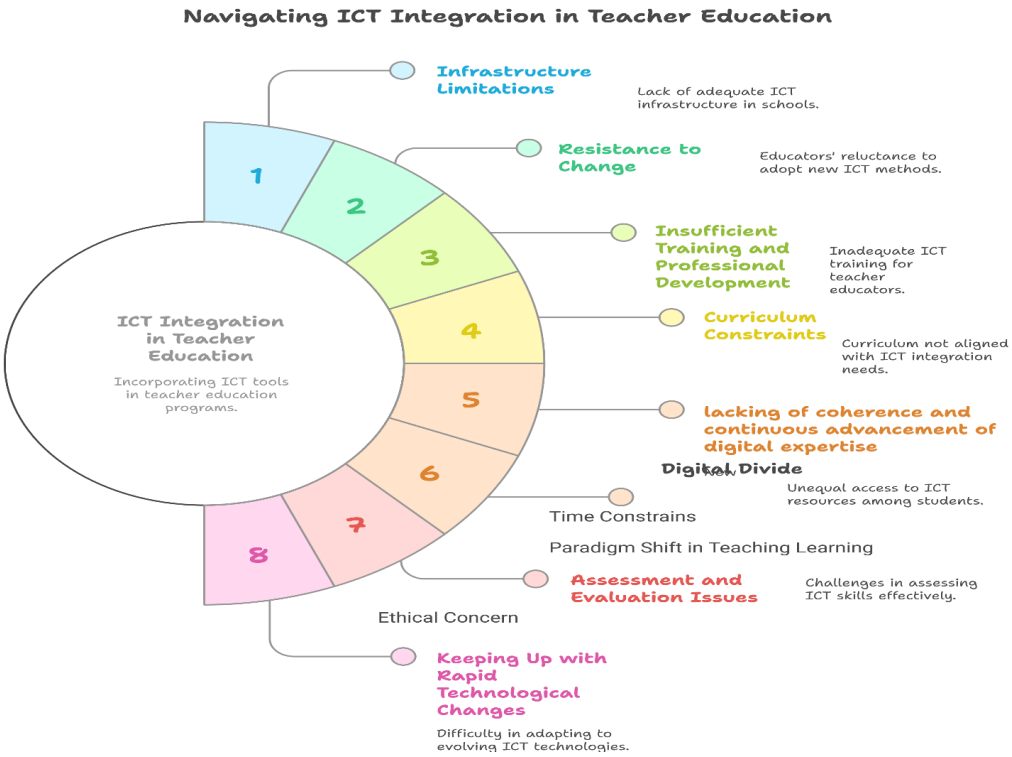
The third central theme is Professional Development and Learner Focus related to sub-themes (Professional development, Students (childhood to university), and Lifelong Learning), focusing on **professional engagement**, **student-centered learning**, and **reflective practice** (core to DigCompEdu). It also connects to **contextual and pedagogical knowledge** in TPACK.

Challenges In Integrating ICT in Teacher Education

Digital Divide: Not every learner or educator program has the required web access, software, or hardware. Ensuring that learners and teachers have fair distribution of technology and the supplies of resources they need is a significant problem in closing the technological gap (Pathak et al., 2023)

- **Infrastructure Challenge:** It can be expensive and expensive to set up and sustain the necessary technology facilities, such as computer laboratories, rapid internet access, and the latest software. (Pathak et al., 2023)& (Karunakaran & Dhanawardana, 2023)**.**
- **Time Constraints:** A large body of research found that one of the main obstacles to teachers using ICT in their instruction is time constraints and the challenge of planning enough time to utilize computers for courses (Ghavifekr et al.)**.**
- **Teachers' competence:** Qualified teachers who can integrate ICT into instruction are in short supply because teacher training does not include how to use ICT in the classroom. In order to equip pupils with the talents they need for the modern techno-oriented classroom, teachers must learn new abilities due to inadequate instruction. Educators find it challenging to employ ICT resources to enhance teaching and learning (Saha, 2023)**.**
- Even with the creation of national or EU frameworks for digital competencies, there is still a tendency among young professionals and educators during service training toward a lack of coherence and continuous advancement of digital expertise.(Kaminskienė et al., 2022)
- There is a cognitive divide between inexperienced in-service teachers and seasoned teachers through advocacy, in-service training, and occasional initiatives to build capacity(Sharma, 2022)**.**
- There is inadequate training for educator trainers. Lacking educators' complete support and devotion to teaching, we cannot bring ICTs into teacher education. There are not many myths

about employing these tools in the training of educators.(Singh, Gaurav & kumar ,Girijesh., 2010).



- Fixing specific technological problems requires expertise because inexperienced operators sometimes cause issues that interrupt the online session. This situation challenges the person in charge when no one else can resolve the problem (Tyagi, 2023).
- Offering Technical Assistance for the Use and Upkeep of Technologies (Vijaykumar, 2011) with Ethical Concerns.
- Paradigm Shift in Teaching, Learning, and Availability of Open Education Resources.

Objective 4: Recommendations/Suggestions regarding ICT Integration in the Teacher Education Program

- It is preferable to look for more efficient knowledge-sharing strategies. Educators should incorporate these cutting-edge concepts into instructional strategies to satisfy the needs and aspirations of society and learners.
- The government should improve the effectiveness and efficiency of education and training. They should connect schools and curricula to the developing networks and information resources.

- The stakeholders and college authorities should have enough facilities and resources to implement ICT integration practically in teacher education.
- There should be proper strategies and policies that open the minds of teachers to adopting ICT.
- Software developers, educators, and teachers should collaborate to design a suitable form of software that addresses diverse teaching and learning competencies for better teacher and student development.
- Study of disruptive Technology and the present scenario of ICT implementation in schools and teacher education institutes, and designing e-contents, strategies, and training modules on content-ICT-pedagogy integration based on the new pedagogical and curricular framework suggested in NEP 2020.
- In-service and pre-service training should reflect ICTs in pedagogical analysis.
- Design and prepare digital education platforms at the national and state levels, including portal learning apps and blockchain technology, per the rising educational needs.
- Collaboration and coordination with national and state-level institutions to ensure better implementation of ICT integration in teacher education.
- Teachers should get enough opportunities to practice using technology more practically during teacher training programs.

Conclusion

ICT calls for a shift in the role of the teachers, who will be endowed with new responsibilities and expertise beyond the classroom walls to allow quality education. The National Education Policy also recommends the successful use of disruptive technology. The government of India is promoting the integration of digital technology at every stage of education, from school age to higher education, by coming up with various digital initiatives. The review has explored the integration of technology in teacher education, such as TPACK, SAMR, Communities of Inquiry framework, Bloom's classification, Constructivist and connectivism approach, UTAUT framework, and the Technological Acceptance Model (TAM), and how these models guide teachers in designing and adopting digital pedagogical approaches. Secondly, various digital initiatives supported by the government of India, like DIKSHA, SWAYAM, Swayam Prabha, National Digital Library, e-Vidya, ARPIT, Virtual Labs Platform, etc., to enable digital infrastructure in teacher training institutes to promote digital competence and capacity building for

pre-service and in-service teachers. The study further identified significant challenges in implementing the NEP 2020 vision regarding digital literacy in teacher education. Finally, the study analyzed NEP 2020's recommendations under the 23rd and 24th bullet, focusing on integrating technology at all stages of teacher education. Policy advocates for continuous professional development through various refresher courses and short-term courses to foster a digitally fluent workforce. In teaching, incorporating technology allows teacher educators to engage in interactive and creative learning methods to address infrastructural disparities and upbringing teacher training programs to support reflective and adaptive teaching practices. Implementing the NEP's digital vision must be holistic and inclusive to ensure that future educators are well-equipped for the demands of 21st-century classrooms.

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