

Article

Navigating the Digital Frontier: A Qualitative Inquiry into Pre-Service Teachers' Digital Competence in India

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Abstract:

Digital competence is now a basic professional requirement for teachers, but its development in teacher education programmes is uneven, especially in the Global South. This qualitative study explores how 36 pre-service teachers (PSTs) in India experience and describe digital competence, and how they deal with related challenges in teaching, assessment, professional engagement, and learner empowerment. Using semi-structured online interviews and reflexive thematic analysis, the study shows that basic infrastructural problems, such as unreliable internet, unequal access to resources, and limited institutional investment, create a ceiling that prevents more advanced use of technology in teaching. On top of these structural issues, PSTs struggle with maintaining integrity in digital assessment, handling AI-related ethical questions, and helping students become competent and responsible digital users. Across all areas, participants strongly preferred practical, hands-on, pedagogy-focused training instead of the mainly theoretical input they currently receive. The findings support the relevance of the DigCompEdu and TPACK frameworks in this under-researched context and highlight a serious gap between teacher education curricula and the actual digital conditions in classrooms. The study adds to qualitative research on pre-service teacher digital competence in the Global South and offers context-specific ideas for curriculum change and institutional policy.

Keywords:

Digital Competence, Pre-Service Teachers, Digcompedu, Teacher Education, Qualitative Inquiry, India

1. INTRODUCTION

Educational digitalisation is no longer just about adding tools and platforms. It has changed the basic conditions of teaching, learning, and professional practice (Akar et al., 2025; Mhlana, 2024). In this new context, digital competence (DC), understood as the combined knowledge, skills, and attitudes needed to use information and communication technologies (ICT) in a pedagogically sound, critical, and creative way, has become an essential professional quality for teachers (Dolezal et al., 2025; Tomczyk, 2024). The COVID-19 pandemic brought this into sharp focus. The sudden worldwide move to remote

teaching in 2020 exposed major weaknesses in teachers' digital readiness and showed that many of these gaps existed long before the crisis (Oguguo et al., 2023; Pyżalski & Walter, 2021).

In response, researchers and policy makers have created frameworks to describe and assess teacher digital competence. The European Digital Competence Framework for Educators (DigCompEdu) (Redecker, 2017) sets out six main domains: professional engagement, digital resources, teaching and learning, digital assessment, empowering learners, and facilitating learners' digital competence. It has become a widely used international reference point for

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structuring and evaluating multidimensional constructs (Caena & Redecker, 2019). The Technological Pedagogical Content Knowledge (TPACK) model (Koehler & Mishra, 2009) adds that meaningful use of technology depends on the overlap of technological, pedagogical, and content knowledge, rather than building each of these separately. Together, these frameworks present professional digital competence (PDC) as a holistic capacity rooted in practice, not simply a list of technical skills (Basilotta-Gómez-Pablos et al., 2022; Starkey, 2019).

However, there is still limited research on how PDC actually develops in practice, particularly for pre-service teachers (PSTs) in non-Western, resource-constrained contexts. Studies regularly point to a gap between the level of digital competence that teacher education programmes aim for and the level that graduates actually reach (Aleksieva, 2025; Göltl et al., 2024; Tzafilkou et al., 2023). PSTs often say that their training is not practical enough, and many build their digital skills through informal, self-directed learning rather than through formal coursework (Dolezal et al., 2025). The obstacles are both structural, such as poor infrastructure, weak institutional support, and limited resources, and dispositional, such as low confidence and attachment to familiar teaching practices (Bereczki & Kárpáti, 2017; Rahmawati et al., 2025).

This lack of empirical work is particularly noticeable in India, where rapid, ambitious efforts to digitalise education sit alongside deep infrastructural inequalities and a teacher education system that remains under-researched. The National Capital Territory of Delhi, with its large, diverse, and socially mixed education system, is an especially important context in which to study these issues. Large-scale quantitative research can identify broad patterns but cannot show how PSTs in particular settings understand and deal with digital competence in their daily institutional and social environments. This study responds to that gap with a qualitative design. It focuses not only on whether PSTs have certain digital skills, but on how they experience the challenges and hopes that shape their digital professional development.

The study is guided by three research questions: (1) What challenges do PSTs encounter across the DigCompEdu domains of digital competence? (2) What forms of training and institutional support do PSTs think are necessary for meaningful digital development? (3) What curriculum changes do PSTs believe are needed to prepare them better for digitally integrated teaching? Using reflexive thematic analysis of semi-structured interviews with 36 PSTs, the study offers context-specific, theoretically informed insights intended to guide curriculum reform, institutional policy, and future qualitative research on teacher digital competence in the Global South.

2. METHODOLOGY

2.1. Research Design and Epistemological Positioning

This study uses a qualitative interpretive design grounded in an interpretivist–constructivist epistemology. It assumes

that understandings of professional competence are shaped socially through lived experience and cannot be fully captured through measurement alone (Creswell & Poth, 2024). The choice of method was intentional. Following long-standing arguments in qualitative inquiry, research on complex professional practice, including how teachers make sense of technology, is better served by approaches that focus on meaning, context, and reflexivity rather than methods aimed mainly at testing prior hypotheses (Denzin & Lincoln, 2018). For the questions this study addresses, a qualitative design was not only suitable but also necessary at the epistemological level.

2.2. Participants and Sampling

Thirty-six pre-service teachers enrolled in teacher education programmes in Delhi, India, took part in the study. Participants were recruited through convenience sampling, a common approach in exploratory qualitative work where access and willingness to take part are central concerns (Creswell & Poth, 2024). They represented a range of subject specialisations and were at different stages of their teacher preparation. All had some previous exposure to digital tools in their programmes, although the extent and type of this exposure varied considerably. This variation was itself analytically important. To protect anonymity, participants are referred to as PST1–PST36.

2.3. Data Collection

Data were gathered through online semi-structured interviews. This method allowed the researcher to follow participants' own accounts while still covering the main concepts of interest in a systematic way (Creswell & Poth, 2024). The interview guide contained fifteen open-ended questions linked to the six DigCompEdu domains and addressed digital tool use in teaching, professional engagement, digital assessment, learner empowerment, support for learners' digital competence, and curriculum reform. Interviews were conducted online for ease of access. Responses were collected in written form and compiled for analysis.

2.4. Analytical Procedure: Reflexive Thematic Analysis

Data were analysed using reflexive thematic analysis (RTA) based on the six-phase process described by Braun and Clarke (2006, 2021). This approach was chosen not only for its clear steps but also because it views the researcher as an active, reflexive participant in the production of meaning, in line with the interpretivist stance of this study. In Phase 1, all responses were read and reread to build strong familiarity with the data. In Phase 2, the researcher carried out systematic, inductive open coding of each meaningful unit of text. In Phase 3, related codes were grouped into potential themes. In Phase 4, these themes were checked against the full dataset to ensure they were coherent within themselves and distinct from each other. In Phase 5, themes were refined, and clear definitions and names were developed. In Phase 6, the current report was written, weaving the themes into a coherent account supported by participant quotes. Coding was driven by

the data throughout, so that interpretations stayed close to participants' voices and were not forced to fit prior theory.

2.5. Rigour and Trustworthiness

Trustworthiness was addressed using the four criteria outlined by Lincoln and Guba (1985). Credibility was supported by sustained engagement with the data and the use of rich, verbatim extracts from participants. Dependability was enhanced through clear documentation of analytic decisions. Confirmability was addressed by linking interpretations directly to the data. Transferability was supported by detailed description of the Delhi context, so that readers can judge how far the findings may apply to other settings.

2.6. Ethical Considerations

The study followed established ethical guidelines for qualitative research. All participants gave informed consent before taking part. Participation was voluntary, with no academic or professional penalty for declining. Confidentiality and anonymity were maintained using participant codes. Data were used only for academic purposes. Ethical approval was obtained from the relevant institutional committee before data collection.

3. FINDINGS

The analysis produced fifteen themes organised across six domains aligned with DigCompEdu (Redecker, 2017). Because participants' accounts of digital competence were detailed and complex, results are presented by domain rather than by interview question. Each domain brings together relevant responses, and selected verbatim quotes are included to support each theme. The interpretation is reflective and critical, placing participant voices in conversation with wider theoretical and policy discussions on digital teacher preparation (Falloon, 2020; Koehler & Mishra, 2009).

3.1. Domain 1: Digital Resources and Teaching – Infrastructure as the Core Obstacle

The most pervasive finding concerns the central role of weak infrastructure in shaping PSTs' digital experiences. Across all domains, participants described unstable internet connections, outdated hardware, and limited access to devices as a structural ceiling that constrained even those who were highly motivated. Reports of *“technical issues such as slow internet connectivity”* (PST2) and *“poor internet connection and old physical objects”* (PST22) appeared repeatedly rather than as isolated complaints. PST28 pointed out the institutional dimension: *“many digital resources require paid subscriptions which are often not provided by institutions.”*

This finding challenges the view that digital readiness is mainly an individual trait. It instead fits with the idea of the digital divide as a layered phenomenon (Van Dijk, 2020) that includes gaps in access, skills, and use. The data show that even when PSTs are motivated and have basic digital skills, poor infrastructure prevents them from trying out more innovative teaching practices. This reflects recent

work from other Global South contexts (Rahmawati et al., 2025; Zeng et al., 2025), which finds that limited institutional resources often undercut policy goals related to digital transformation in teacher education.

The digital divide appeared at several levels. For some participants, the barrier lay in their own skills: *“I have limited knowledge of digital resources”* (PST9). For others, it lay with students: *“not every child is using digital technology when it comes to online classes or home assignments”* (PST26). Together, infrastructural, financial, and competence-related inequalities created what many experienced as an ongoing and cumulative limit on digital integration. This supports Rawal's (2024) idea that Indian teacher education faces a “triple divide” of access, pedagogical modelling, and curricular integration.

3.2. Domain 2: Professional Engagement – Communication, Collaboration, and Platform Overload

In the domain of professional engagement, participants saw communication and collaboration as the hardest areas. Moving professional relationships into digital spaces made them more fragile than previous face-to-face interactions. Responses such as *“collaboration becomes difficult due to different levels of digital skills among colleagues”* (PST2) and *“delayed responses in online collaboration”* (PST15) point to a core problem: successful professional work with digital tools assumes a shared competence level that is not yet present across this group. This mirrors findings by Göttl et al. (2024), who argue that effective digital collaboration among teachers depends on collective, not just individual, competence.

The use of many different platforms also created both cognitive and organisational strain. PST27 described *“compatibility issues between different tools”* and *“managing multiple platforms”* as confusing. PST22 mentioned *“tool fatigue,”* capturing the feeling of being overwhelmed by several poorly linked systems without enough support from institutions. This suggests that digital professionalism involves organisational and emotional work as well as technical skills (Tzafilkou et al., 2023). The lack of standard platforms across institutions meant that PSTs had to put significant effort into managing logistics, which reduced the time and energy available for pedagogical reflection. This kind of hidden labour is rarely recognised in competence frameworks.

3.3. Domain 3: Digital Assessment – Integrity, Data, and Ethical Uncertainty

Digital assessment was an especially anxiety-laden area. Participants reported difficulties across all stages of assessment work: designing tasks, running assessments, interpreting data, and judging authenticity. Statements such as *“I didn't know about the digital tools for assessment”* (PST7) and *“difficulty arises in designing quizzes, setting up automated grading”* (PST33) show significant gaps in assessment-specific digital skills. Data management was another source of concern, with some referring to *“data overload”* (PST4) and to struggles with *“analysing data through digital dashboards”* (PST33), which suggests a lack

of preparation in using assessment data.

Concerns about academic integrity and fairness were particularly strong. PST36 summed up a widely shared worry: *“fairness and authenticity of the responses is also a challenge whether it is copied or truly written by students.”* PST25 similarly noted, *“It is difficult to ensure fairness and accuracy in online assessments.”* The growing use of AI-generated content made these concerns more intense, turning digital assessment into an ethical as well as a technical issue.

This finding is in line with Coşgun’s (2025) global review of assessment after the arrival of tools like ChatGPT, but the current study adds an important detail. PSTs in resource-constrained settings face a layered vulnerability in assessment. They often lack basic training in assessment design and at the same time have little guidance on the ethical use of AI. As Máñez et al. (2024) argue, assessment literacy now needs to include critical awareness of AI, yet most teacher education programmes have not adapted. Asking novice teachers to judge authenticity and handle AI-related dilemmas without preparation is both unrealistic and potentially unfair to their future students.

3.4. Domain 4: Empowering Learners – Motivation, AI Dependence, and Tool Limits

One of the most striking findings is that PSTs did not see digital tools as automatically empowering learners. Instead, they described digitally mediated classrooms as spaces where motivation was fragile and where distraction and overreliance on AI were growing problems. PST8 observed that *“the creativity of students and reading skills are worsening and most importantly the attention span of the student reduces day by day.”* PST2 remarked that *“students these days are too much AI dependent; they are not thinking much creatively.”*

These accounts complicate simple “technology is good” narratives. The challenge is not just to introduce digital tools but to use them in ways that support deep thinking, creativity, and self-regulation. PST33 noted that students can become *“more interested in the tool than the task,”* capturing the tension between surface engagement and meaningful learning. For participants, learner empowerment was therefore a matter of design and pedagogy rather than technology alone.

This finding questions the technological determinism sometimes seen in digital education policy (Selwyn, 2021). Even in the DigCompEdu framework (Redecker, 2017), the “Empowering Learners” domain is often less clearly translated into practice. The data suggest that, without explicit pedagogical models, digital tools can actually reduce learner autonomy and creativity. This supports Choi’s (2016) argument that digital citizenship education should include critical reflection on technology use, not just the development of technical skills.

3.5. Domain 5: Facilitating Learners’ Digital Competence – Ethics, Literacy, and System-Level Gaps

The domain of facilitating learners’ digital competence, which is the most advanced in DigCompEdu, was where the gap between curriculum and practice was most visible. Participants found it particularly hard to teach digital responsibility, address misinformation, deal with plagiarism, and support ethical online behaviour. PST25 described students who *“copy online material without understanding plagiarism or digital ethics.”* PST2 emphasised the problem of misinformation: *“there is a lot of fake and misleading data available, so it is very essential to instruct them accordingly.”*

Several participants pointed to missing curricular structures as a key reason for these problems. According to PST33, *“in many schools, digital literacy is not systematically included in the curriculum, so it is difficult to facilitate learners’ digital competency.”* PST19 referred to *“a lack of pedagogical models for responsible tech use.”* Together, these accounts suggest that digital citizenship education in teacher education programmes often exists more in policy language than in classroom practice.

This points to a wider implementation gap between policy and reality. International guidelines, such as those from UNESCO (2021), emphasise that digital citizenship is a lifelong learning process that should be incorporated into national education systems (as cited in Ahmadova, K. A. Q., & Qalandarova, S. O. Q., 2025), but the data here show that even motivated PSTs rarely receive this kind of guidance. This aligns with Aleksieva’s (2025) claim that the most demanding DigCompEdu domain is usually the least developed in teacher preparation. Without curricular reform at the system level, efforts to build learners’ digital competence will remain patchy and heavily dependent on individual teachers.

3.6. Domain 6: Training Needs and Curriculum Reform – A Strong Demand for Practical Pedagogy

Across the whole dataset, one preference was repeated again and again. PSTs wanted practical, hands-on, and pedagogy-focused training in place of the largely theoretical teaching they currently receive. The term “workshop” appeared very frequently. PST2 explained, *“I would benefit from hands-on training sessions and workshops focused on using digital tools like LMS, presentation software, and content creation apps.”* PST8 directly linked this to competence: *“practical workshop specifically to build digital competency.”*

Participants were also clear about how they wanted the curriculum to change. Most argued for integrating technology into existing subjects rather than offering ICT as a separate, isolated course. PST10 suggested, *“integrate technology into all subject areas, not just as a separate course.”* PST22 proposed a broader approach: *“embed digital pedagogy, critical media literacy, and adaptive technology use tailored to diverse learning contexts.”* PST13 gave a concrete example: *“require project-based assignments using digital tools, such as creating a complete blended learning unit.”* Many also called for compulsory modules on digital safety,

AI ethics, and data privacy, showing their sense that digital competence is closely tied to ethical practice.

These findings offer strong empirical support for the TPACK framework (Koehler & Mishra, 2009), which holds that effective technology integration depends on developing technological, pedagogical, and content knowledge together. PSTs' rejection of stand-alone ICT courses and their call for subject-embedded digital pedagogy reflect TPACK's core message. Their emphasis on ongoing professional development instead of one-off events also matches Dolezal et al. (2025), who argue for sustained, practice-based structures for digital learning in teacher education.

4. DISCUSSION

The study presents pre-service teachers' digital competence as a layered, context-dependent, and institutionally shaped construct. Four overlapping arguments emerge.

4.1. Infrastructure as an Essential Starting Point

The data clearly show that digital competence cannot develop in any meaningful way without basic infrastructural support. Problems such as unreliable internet, too few devices, and weak institutional investment do more than make life difficult. They set the upper limit for what teachers can do pedagogically. This is in line with global work on digital divides in teacher education (Rahmawati et al., 2025; Zeng et al., 2025), but it is particularly urgent, where policy goals often far exceed material conditions. Rawal's (2024) findings on Indian school teachers point to a similar bottleneck, suggesting that the current study reflects a wider pattern.

One new contribution here is the description of how infrastructure interacts with motivation and self-belief. PSTs who felt confident with digital tools often did so because they compensated for institutional gaps by using their own devices, mobile data, and free software. While resourceful, this pattern cannot be a long-term answer. It shifts responsibility from institutions to individuals and risks widening inequalities. For digital competence to develop fairly, institutions must take responsibility for providing the material basis for professional learning.

4.2. The Training Gap and the Need for Practical Pedagogy

The strong and consistent demand for hands-on, practice-oriented training instead of mainly theoretical input matches many recent studies on teacher digital competence (Dolezal et al., 2025; Karimi & Khawaja, 2025). As Falloon (2020) notes, teacher education systems have often failed to meet this demand. TPACK (Koehler & Mishra, 2009) helps explain why: when digital skills are taught separately from pedagogy and subject knowledge, they do not easily transfer into classroom practice. PSTs in this study recognised this. Their calls for project-based work, microteaching that uses learning management systems, and ICT integrated into subject pedagogy are rooted in a clear understanding that digital competence is about teaching practice, not just tool use.

The data also show that PSTs do not simply want more exposure to technology. They want training that demonstrates how technology, pedagogy, and content work together and that treats them as reflective professionals, not just operators of tools. This has important implications for curriculum design. A session on how to use a specific platform is very different from a session on how to design learning activities on that platform that promote discussion and critical thinking. The former treats competence as technical; the latter treats it as pedagogical. Participants' comments suggest they are asking for the second type of training, and programmes that continue to offer only the first are unlikely to produce confident graduates.

4.3. Digital Assessment and AI Ethics

Participants' strong concerns about assessment integrity, especially around AI-generated work, place them within a global debate about assessment in the age of generative AI (Coşgun, 2025). However, in this context the challenge is intensified. PSTs must cope with limited assessment training, weak data analysis skills, and significant ethical uncertainty at the same time, and they often do so without effective institutional support.

This combined pressure has serious consequences. PSTs are being asked to take decisions about AI, such as identifying AI-written work or designing assessments that are less vulnerable to misuse, before they have mastered more basic aspects of assessment design. Expecting this of novices without specific preparation is likely to produce stress and inconsistent practice. The findings suggest that assessment literacy now needs to be redefined to include critical understanding of AI from the outset and not as an optional extra (Coşgun, 2025; Máñez et al., 2024).

Learner Empowerment as a Design Question Rather Than a Technology Question
Another key finding is that participants did not see digital tools as automatically empowering learners. In some cases, they felt that poor digital integration actually harmed student attention and creativity and encouraged superficial use of AI. This matches the most demanding aspect of DigCompEdu, "*Facilitating Learners' Digital Competence*," which involves helping students build critical, ethical, and autonomous engagement with digital environments (Aleksieva, 2025; Redecker, 2017).

PSTs' observations about shrinking attention spans and rising AI dependence are supported by wider research on how uncritical use of digital tools can lower cognitive demand while creating the impression of engagement. For teacher education, the message is clear. PSTs need not only access to tools but also the skills and confidence to decide when and how to use them so that they support rather than replace thinking. This includes knowing when technology may not be helpful for particular learning goals.

5. CONCLUSION

This study examined how pre-service teachers in India experience and navigate digital competence using the DigCompEdu framework as a reference. The findings

show a clear and challenging picture. Digital competence development among PSTs in this context is limited by ongoing infrastructural problems, weakened by training that emphasises theory over practice, and made more complex by new ethical questions around AI in teaching and assessment. The distance between what current teacher education curricula offer and what real classrooms require is large enough to be considered a systemic problem rather than a minor misfit.

The study makes three main contributions. First, it supports the use of the DigCompEdu and TPACK frameworks in a Global South setting that has received little attention, showing both their usefulness and the ways that local conditions shape how each domain appears in practice. Second, it identifies digital assessment integrity and learner empowerment as the areas that provoke the greatest concern among PSTs, highlighting curriculum gaps that have not been widely documented in the Indian context. Third, it brings together a set of detailed participant accounts that can inform concrete curriculum and policy decisions.

For teacher educators and policymakers, the practical messages are straightforward. Investment in infrastructure

must come before, or at least alongside, curriculum reforms, because training that is not backed by reliable connectivity is largely symbolic. Assessment literacy, including ethical and AI-related aspects, needs to be treated as a central, examinable part of teacher education. Digital pedagogy should be woven through subject curricula rather than confined to standalone ICT modules. Supporting learners' digital citizenship, including critical media literacy, ethical technology use, and responsible engagement with AI, should be recognised as a core professional responsibility.

Future research could track digital competence development over time, from teacher education into in-service practice, using mixed-method designs that combine self-reports with observation or performance tasks. Comparative work across urban and rural areas within India, and between India and other countries in the Global South, would deepen understanding of how infrastructure, policy, and culture interact in shaping digital competence. Given the rapid growth of generative AI in education, the ethical and assessment-related aspects of digital competence require particular attention in upcoming studies.

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Author(s) Contribution

All the Author(s) work equally to prepare the manuscript.

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The data supporting this study are not publicly

available in order to protect participant confidentiality. Requests for access can be directed to the corresponding author.

Competing Interests

The author(s) report no potential conflicts of interest with respect to the research, authorship, or publication of this article.

Clinical Trial Registration (if applicable)

Not Applicable

Human Ethics and Consent to Participate

The study did not involve any clinical interventions or experiments requiring formal ethical approval.

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