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Examining the Relationship between Demographic Factors and Digital Literacy Competencies among Pre-Service Teachers

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Abstract

In this study, pre-service teachers in Rajasthan, India, had their digital literacy skills and demographic characteristics compared. Data were gathered from 80 pre-service teachers in four districts of Rajasthan using a descriptive survey design. The study looked into the effects of factors like gender, location, academic program, and type of institution on digital literacy levels. The results showed notable differences in digital literacy skills according to demographic traits, which has consequences for the state's teacher preparation initiatives and policy changes.

Keywords: Digital literacy, pre-service teachers, demographic factors, teacher education, Rajasthan

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Introduction

The rapid integration of digital technologies into teaching and learning processes was a major factor in the unprecedented shift in educational paradigms that occurred in the 21st century. Digital literacy, which includes not only the ability to use technology but also the ability to critically assess, produce, and disseminate information via digital platforms, has become a critical competency for educators (Martin & Grudziecki, 2006). Digital literacy is a crucial part of teacher preparation programs in India, where programs like the National Education Policy (NEP) 2020 have highlighted the use of technology in the classroom.

As aspiring educators, pre-service teachers were at a turning point in their careers where their digital skills would have a big impact on how the next generation used technology. However, there was variation in the development of these competencies, and it seemed that different demographic factors, such as gender, location, educational background, and institutional contexts, had an impact (Tondeur et al., 2012). Designing successful teacher education programs that could close current digital divides required an understanding of these relationships.

One of the biggest states in India, Rajasthan, offered a special setting for studying pre-service teachers' digital literacy. From metropolitan areas to rural hinterlands, the state featured a wide range of geographical settings with differing degrees of educational resources and technology infrastructure. Rajasthan's digital divide was indicative of larger national trends in which different demographic groups continued to have unequal access to technology and digital literacy skills (Sharma & Chandel, 2020).

Theoretical Framework

Two complementary theoretical stances served as the foundation for this study. First, a thorough framework for comprehending digital literacy as a multifaceted construct that includes professional engagement, digital resources, teaching and learning, assessment, empowering learners, and facilitating learners' digital competence was offered by Redecker

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(2017) in his Digital Competence Framework for Educators (DigCompEdu). Second, the Social Cognitive Theory (Bandura, 1986) provided insight into how environmental and demographic factors affected the development of digital literacy through the mechanisms of reciprocal determinism, self-efficacy, and observational learning.

These frameworks' intersection implied that pre-service teachers' development of digital literacy was intricately entwined with social, cultural, and institutional contexts rather than being solely an individual cognitive process. Future teachers' digital competency profiles were shaped by a variety of factors, including diverse learning opportunities, cultural attitudes towards technology, and unequal access to resources, all of which were proxied by demographic variables.

Context of the Study

A combination of public and private institutions that offered Bachelor of Education (B.Ed.) programs in both urban and rural areas defined Rajasthan's teacher education landscape. The state was a perfect place to look into the relationship between demographic factors and the development of digital literacy because of its diverse population and the ongoing infrastructure gaps between rural and urban areas. While locality-based disparities in digital access continued to be a persistent challenge, prior research conducted in Indian contexts had highlighted gender-based differences in technology adoption and confidence levels (Rana & Rana, 2020).

As educational institutions transitioned to online and hybrid modes of instruction, the COVID-19 pandemic (2020–2021) further highlighted the significance of digital literacy. Like their counterparts worldwide, pre-service teachers in Rajasthan had to quickly adjust to digital platforms, which exposed both their digital competency gaps and their strengths. During the post-pandemic recovery phase (2022–2023), this study was carried out as educational institutions were considering the lessons they had learnt and incorporating digital literacy more methodically into their curricula.

Research Objectives

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The present study was designed to achieve the following objectives:

RO1: To assess the level of digital literacy competencies among pre-service teachers in Rajasthan.

RO2: To examine the relationship between demographic factors (gender, locality, stream, and institutional type) and digital literacy competencies of pre-service teachers.

RO3: To identify significant differences in digital literacy competencies across different demographic groups of pre-service teachers.

Research Design

In order to examine current conditions and relationships among variables in their natural settings without manipulation, this study used a descriptive survey research design (Creswell & Creswell, 2018). A thorough analysis of digital literacy skills and their relationships to demographic traits in a geographically heterogeneous sample was made possible by the descriptive approach. All three research objectives were methodically addressed by the design, which made it easier to measure digital literacy levels quantitatively and compare them across demographic subgroups.

Research Methodology

Population and Sample

All pre-service teachers enrolled in B.Ed. programs at different teacher education institutions in Rajasthan during the academic year 2023–2025 made up the study's population. A stratified random sampling technique was used to guarantee sufficient representation across important demographic variables due to the practical limitations of reaching the entire population.

Eighty pre-service teachers were selected from four districts in Rajasthan: Pali (primarily rural), Sikar (rural-urban mix), Ajmer (semi-urban), and Jaipur (urban centre). In order to reflect the state's geographic and developmental diversity, these districts were specifically chosen. To ensure representation across institutional types, gender, place of origin, and

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academic streams (Arts, Science, and Commerce), B.Ed. institutions were chosen at random within each district, and pre-service teachers were drawn proportionately from both government and private institutions.

The demographic distribution of the sample was as follows: Gender (Male: 38, Female: 42), Locality (Urban: 45, Rural: 35), Stream (Arts: 32, Science: 28, Commerce: 20), and Institutional Type (Government: 33, Private: 47).

Research Instrument

A standardized Digital Literacy Competency Scale (DLCS) was developed and employed as the primary data collection instrument. The scale was constructed based on the DigCompEdu framework and consisted of 40 items organized across six dimensions: (1) Information and Data Literacy, (2) Communication and Collaboration, (3) Digital Content Creation, (4) Safety and Security, (5) Problem Solving, and (6) Professional Engagement. Each item was rated on a five-point Likert scale ranging from 1 (Not Competent) to 5 (Highly Competent).

The instrument was rigorously validated. Five faculty members with expertise in teacher education and educational technology conducted an expert review to determine the content validity. With a Cronbach's alpha coefficient of 0.89, the scale showed excellent reliability and high internal consistency. To improve item clarity and guarantee appropriateness for the target population, a pilot study was carried out with 25 pre-service teachers who were not part of the final sample.

Data Collection Procedure

After receiving approval from institutional ethics committees, data collection took place over a three-month period. The chosen institutions in each district were visited by researchers in person. The goal of the study was explained to pre-service teachers, they were given confidentiality assurances, and the importance of voluntary participation was underlined. To account for linguistic preferences, the DLCS questionnaire was given in both Hindi and English. Eighty valid responses were kept for analysis after completed questionnaires were reviewed for completeness.

Data Analysis

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SPSS version 26.0 was used to analyse the gathered data. To evaluate the general degree of digital literacy competencies, descriptive statistics (mean, standard deviation, frequency, and percentage) were calculated (RO1). Digital literacy scores were compared across dichotomous demographic variables, including gender (male vs. female), locality (rural vs. urban), and institutional type (private vs. government), using inferential statistics, specifically independent samples t-tests (RO2 and RO3). The three-level stream variables (Arts, Science, and Commerce) were tested for differences using a one-way ANOVA. If significant differences were discovered, post-hoc tests were performed. For every statistical test, the significance level was set at $\alpha = 0.05$.

Results and Analysis

Overall Digital Literacy Competency Level

Table 1: Overall Digital Literacy Competency Among Pre-Service Teachers (N=80)

Competency Level	Score Range	Frequency	Percentage	Mean Score	SD
Low (1.00-2.33)	Below Average	12	15.0%		
Moderate (2.34-3.66)	Average	48	60.0%	3.42	0.68
High (3.67-5.00)	Above Average	20	25.0%		
Total		**80**	**100%**	**3.42**	**0.68**

Analysis and Interpretation:

The distribution of digital literacy skills among Rajasthan's 80 pre-service teachers was shown in Table 1. Overall, a moderate level of competency was indicated by the mean digital literacy score of 3.42 (SD = 0.68). Just 25% of participants attained high competency levels, whereas the majority (60%) showed moderate levels of digital literacy. Interestingly, 15% of pre-service teachers had low levels of digital literacy, indicating serious deficiencies that needed to be addressed right away.

These results supported the first research goal and showed that although the majority of pre-service teachers had functional digital skills, there was still much space for improvement,

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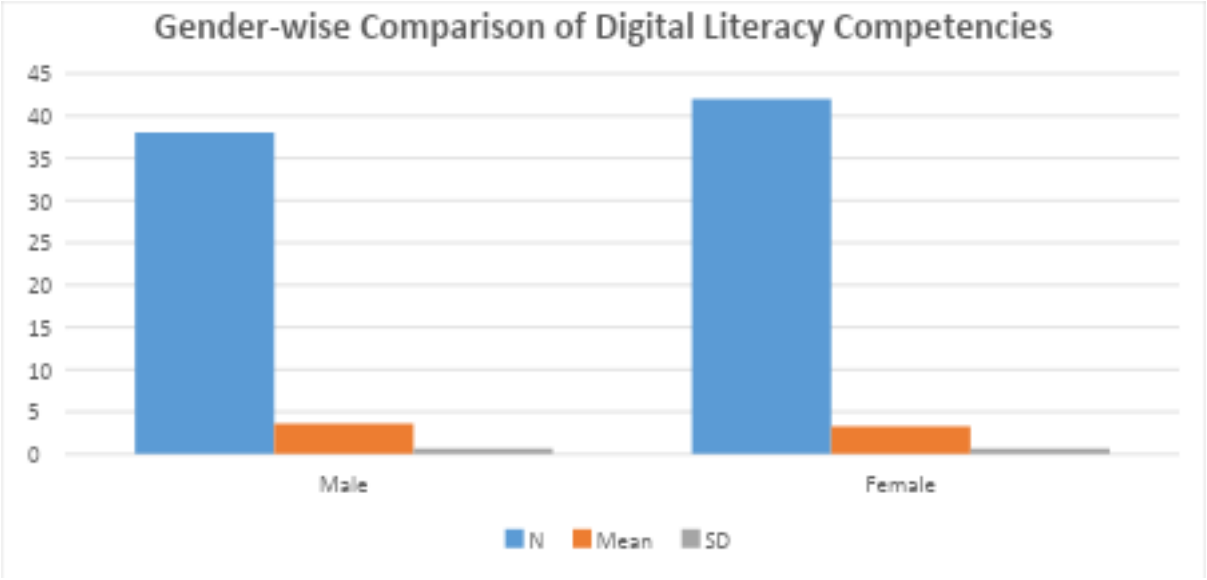
especially in more complex areas like creating digital content and integrating technology into the classroom. The comparatively high standard deviation (0.68) indicated significant variation in the sample's competency levels, suggesting the impact of contextual and demographic factors examined in later analyses.

Gender-Based Differences in Digital Literacy

Table 2: Gender-wise Comparison of Digital Literacy Competencies

Gender	N	Mean	SD	t-value	df	p-value	Significance
Male	38	3.58	0.64	2.17	78	0.033	Significant*
Female	42	3.28	0.69				

*Significant at 0.05 level



Hypothesis Testing:

H_1: There is a significant difference in digital literacy competencies between male and female pre-service teachers.

Analysis and Interpretation:

In contrast to their female counterparts (M = 3.28, SD = 0.69), male pre-service teachers (M = 3.58, SD = 0.64) showed greater digital literacy competencies, according to Table 2. The t-value of 2.17 obtained from the independent samples t-test was statistically significant at the 0.05 level (p = 0.033, df = 78). As a result, the null hypothesis was disproved, demonstrating

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that among Rajasthani pre-service teachers, gender had a significant impact on their digital literacy competencies..

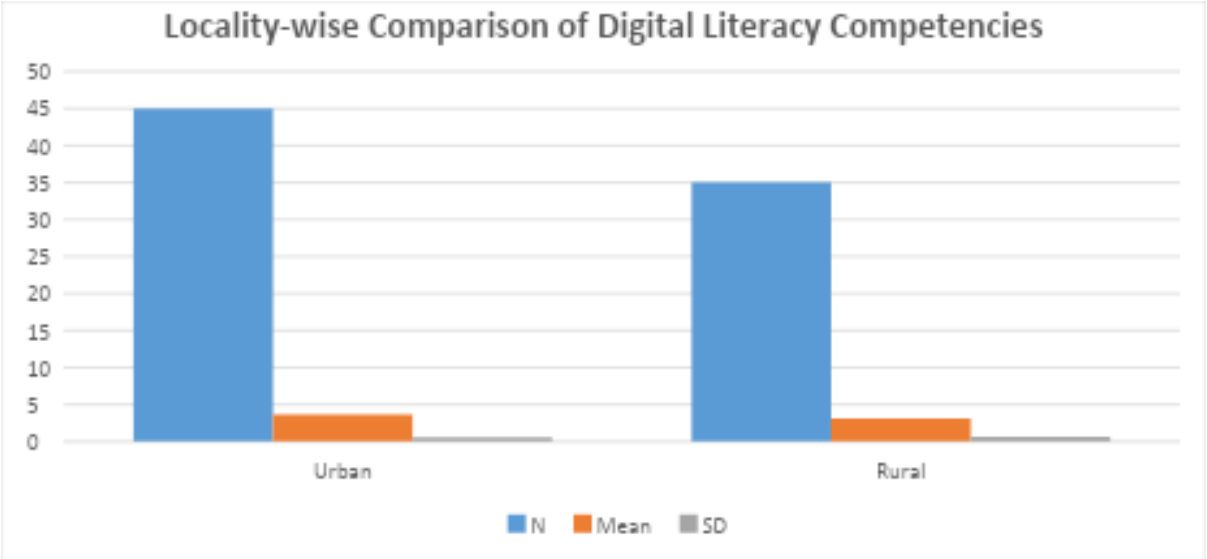
This result implied that there was still a gender-based digital divide in the area. This discrepancy could have been caused by a number of things, such as different access to technology during early life, different degrees of support and encouragement for using technology, and sociocultural elements that influenced user confidence and self-efficacy (Vekiri & Chronaki, 2008). Although the difference was statistically significant, other factors also had a significant impact on digital literacy levels, according to the moderate effect size.

Locality-Based Differences in Digital Literacy

Table 3: Locality-wise Comparison of Digital Literacy Competencies

Locality	N	Mean	SD	t-value	df	p-value	Significance
Urban	45	3.67	0.58	3.85	78	0.000	Highly Significant**
Rural	35	3.09	0.69				

**Significant at 0.01 level



Hypothesis Testing:

H_1: There is a significant difference in digital literacy competencies between urban and rural pre-service teachers.

Analysis and Interpretation:

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Significant regional variations in digital literacy were shown in Table 3. Compared to rural pre-service teachers (M = 3.09, SD = 0.69), urban pre-service teachers (M = 3.67, SD = 0.58) demonstrated noticeably greater digital literacy competencies. The null hypothesis was rejected as a result of the t-test's highly significant result ($t = 3.85$, $p < 0.001$, $df = 78$).

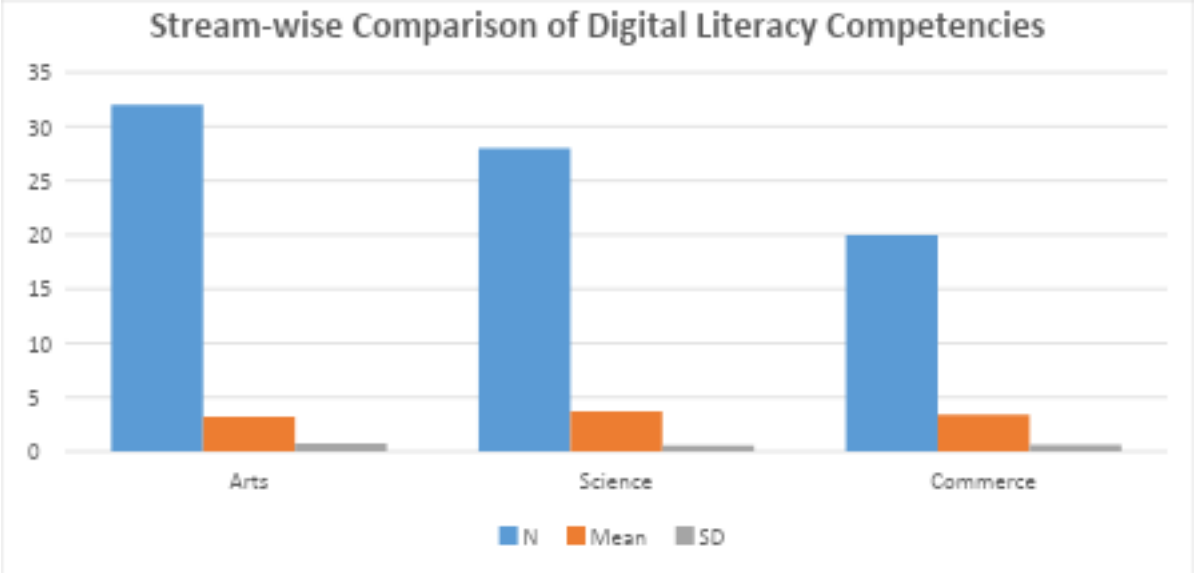
This stark urban-rural divide was a reflection of Rajasthan's larger resource and infrastructure inequalities. Better internet access, more digital device availability, more technologically integrated learning environments, and more exposure to digital culture were all common in urban areas (Sharma & Chandel, 2020). Despite their potential and drive, pre-service teachers in rural areas faced systemic obstacles that constrained their ability to acquire digital skills. Rural participants' higher standard deviation (0.69) also indicated more variation in their experiences and skill levels, which probably reflects unequal access even in rural settings.

Stream-Based Differences in Digital Literacy

Table 4: Stream-wise Comparison of Digital Literacy Competencies

Stream	N	Mean	SD	F-value	df	p-value	Significance
Arts	32	3.21	0.72	5.42	2, 77	0.006	Significant**
Science	28	3.71	0.58				
Commerce	20	3.38	0.65				

**Significant at 0.01 level



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Post-hoc Comparisons (Tukey HSD):

- Science vs. Arts: p = 0.004 (Significant)
- Science vs. Commerce: p = 0.089 (Not Significant)
- Arts vs. Commerce: p = 0.512 (Not Significant)

Hypothesis Testing:

H_1: There is a significant difference in digital literacy competencies among pre-service teachers from different academic streams.

Analysis and Interpretation:

The null hypothesis was rejected because Table 4 showed significant differences in digital literacy competencies across academic streams (F = 5.42, p = 0.006, df = 2, 77). The highest levels of digital literacy were shown by pre-service teachers in the Science stream (M = 3.71, SD = 0.58), followed by those in the Arts (M = 3.21, SD = 0.72) and Commerce (M = 3.38, SD = 0.65).

While differences between Science and Commerce and between Arts and Commerce were not statistically significant, post-hoc analysis showed that the Science stream differed significantly from the Arts stream (p = 0.004). This pattern implied that improved digital literacy was a result of exposure to technology and computational thinking incorporated into science curricula. In order to develop stronger digital competencies, science students generally used digital tools more frequently for data analysis, simulations, and scientific inquiry (Kay, 2006). The need for more deliberate integration of digital literacy development across all disciplinary areas in teacher education was brought to light by the Arts stream students' poorer performance.

Institutional Type-Based Differences

Table 5: Institutional Type-wise Comparison of Digital Literacy Competencies

Institution Type	N	Mean	SD	t-value	df	p-value	Significance
Government	33	3.28	0.75	-1.56	78	0.122	Not Significant
Private	47	3.51	0.62				

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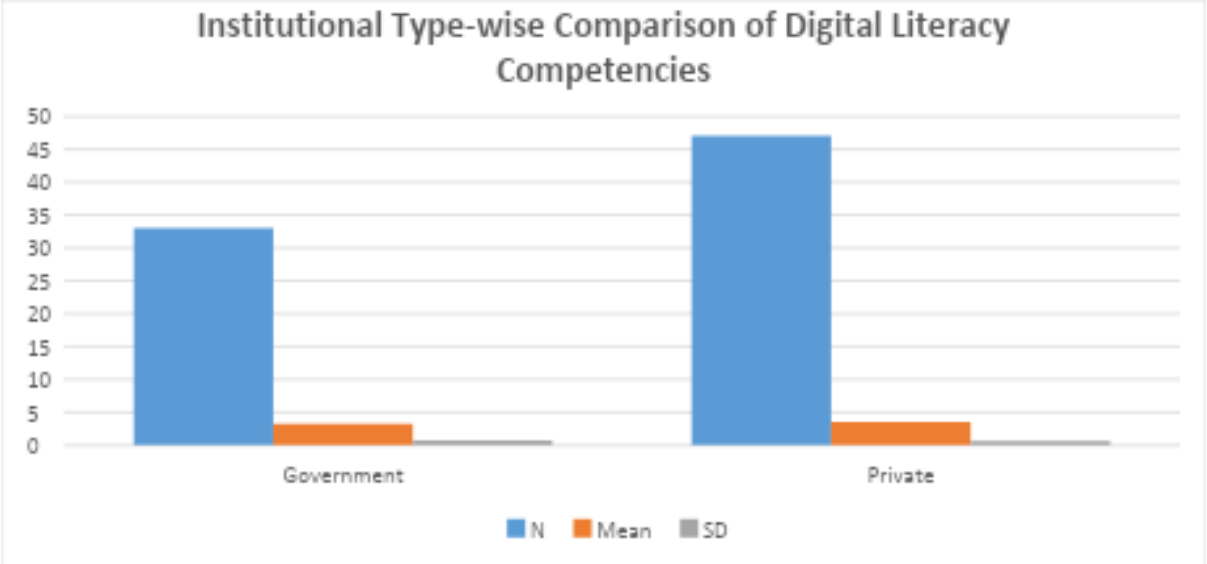

Hypothesis Testing:

H_0: There is no significant difference in digital literacy competencies between pre-service teachers from government and private institutions.

Analysis and Interpretation:

Competencies in digital literacy were compared across institutional types in Table 5. Although students attending private institutions had numerically higher means (M = 3.51, SD = 0.62) than those attending government institutions (M = 3.28, SD = 0.75), the difference was not statistically significant (t = -1.56, p = 0.122, df = 78). Consequently, the null hypothesis was kept.

Considering presumptions regarding resource disparities between public and private institutions, this finding was a little unexpected. It implied that when other factors were taken into account, digital literacy outcomes were not solely determined by institutional type. When it came to successfully incorporating digital literacy into their teacher education programs, both kinds of institutions seemed to encounter comparable difficulties. Higher levels of variability in government institutions (SD = 0.75) suggested that student populations were more diverse or that program quality varied more amongst government colleges.

Discussion

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The study's conclusions offered valuable insights into Rajasthan's pre-service teachers' digital literacy environment, highlighting both promising patterns and areas in need of immediate attention. Although there were some fundamental digital competencies, many participants' depth and breadth of skills required for successful technology integration in future teaching practices were still lacking, according to the moderate overall digital literacy level (M = 3.42).

Gender Disparities in Digital Literacy

The notable gender disparity that favoured male pre-service teachers (RO2 and RO3) was consistent with more general trends observed in Indian educational settings (Rana & Rana, 2020; Verma et al., 2019). Sociocultural norms, unequal access to technology, and differing degrees of encouragement for technology use were the main causes of this discrepancy. In conventional settings, families frequently gave boys' access to electronics and internet connectivity priority, while girls were subject to more limitations on their use of technology (Nath, 2016).

There were important ramifications for teacher education. Stronger digital competencies were necessary for female pre-service teachers, who would likely instruct a sizable percentage of female students, in order to act as role models and close the gender digital divide in the following generation. It was necessary for teacher education institutions to adopt gender-sensitive strategies for the development of digital literacy, such as establishing secure environments for experimenting with technology, filling in confidence gaps with focused assistance, and dispelling myths that technology is a male domain..

The Persistent Urban-Rural Divide

The study's most alarming finding may have been the highly significant difference between pre-service teachers in urban and rural areas (RO2 and RO3). Rural pre-service teachers significantly trailed their urban counterparts, with a mean difference of 0.58 points on the five-point scale. The harsh realities of rural Rajasthan's infrastructure deficiencies, such as erratic internet access, restricted access to computers and smart devices, and fewer opportunities for technology-mediated learning, were reflected in this disparity (Sharma & Chandel, 2020).

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The ramifications went beyond disparities in individual competency to include issues of educational equity. If their teachers lacked the digital skills necessary to successfully incorporate technology into their lessons, rural students—who already face a lack of educational resources—would be even more at a disadvantage. As a result, a vicious cycle of digital disadvantage was established. Policy interventions were desperately needed, such as the development of focused digital infrastructure in rural areas, the distribution of devices to pre-service teachers in rural areas, and specialised training programs that recognised and tackled the particular difficulties of rural settings.

Disciplinary Variations in Digital Competency

The notable stream-based disparities, especially the advantage of Science stream students, indicated that curricula and disciplinary practices were closely related to the development of digital literacy (RO2 and RO3). Higher digital competencies were naturally fostered by the incorporation of more digital tools into science education, which places a strong emphasis on inquiry, experimentation, and data analysis (Kay, 2006). Students in the Arts stream performed worse because they had fewer organised opportunities to learn digital skills as part of their disciplinary studies, not because they were less capable.

The necessity of intentional, cross-curricular approaches to digital literacy in teacher education was brought to light by this finding. Teacher education programs needed to explicitly incorporate digital literacy across all subject areas rather than relying on the development of digital competencies as an afterthought. Teachers in the arts and humanities needed assistance identifying and utilising technology for their teaching objectives, from online research and collaborative platforms to digital storytelling and multimedia production.

Institutional Context and Digital Literacy

It was unexpected and instructive to find that there were no appreciable differences between public and private institutions (RO2 and RO3). It questioned oversimplified notions that better results are a direct result of private institutions' resource advantages. This finding could have been explained by a number of factors. First, pedagogical integration and faculty expertise were just as important as infrastructure availability, which alone did not ensure effective use. Second, there were significant differences in student attributes (such as past

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digital experiences) between the two institutional types, which might have obscured the effects of the institutions. Third, there may be some baseline consistency because the regulatory framework for B.Ed. programs in India set minimum requirements that both kinds of institutions had to fulfil.

The greater variation in government institutions, however, raised concerns about unequal quality and demanded more uniform methods for fostering digital literacy in all kinds of institutions. Clear digital literacy competencies must be set as program outcomes by teacher education regulatory bodies, and accountability for attaining these outcomes must be guaranteed.

Implications for Teacher Education Policy and Practice

All of the results indicated that Rajasthan's teacher education system needed a number of crucial interventions:

- **Targeted Support Programs**: To address the disparities found, gender-sensitive and locally tailored interventions were required. This could involve mentorship programs, workshops to boost confidence, and residential technology camps for female and rural pre-service teachers.
- **Curriculum Redesign:** Rather than being restricted to sporadic technology courses or incidental development, digital literacy needed to be explicitly incorporated into all teacher education curricula. Technology integration should be modelled and practiced in all disciplinary methods courses.
- **Infrastructure Investment:** A sizable investment in digital infrastructure was crucial, especially for institutions located in rural areas. This included consistent technical support, sufficient devices, and dependable internet access.
- **Faculty Development:** In order to teach with technology, teacher educators themselves required improved pedagogical knowledge and digital competencies. Professional development had to follow a cascading model.
- **Assessment and Accountability:** In order to hold institutions responsible for graduate results, digital literacy competencies had to be specifically evaluated as part of the evaluation of teacher education programs.

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Conclusion

A complex landscape of moderate overall competency levels with notable differences across demographic groups was revealed by this study, which looked at the relationship between demographic factors and digital literacy competencies among pre-service teachers in Rajasthan. By evaluating general levels of digital literacy, investigating connections between demographic characteristics and competencies, and spotting notable variations among groups, the study accomplished its three goals.

The main conclusions showed that, although institutional type had no discernible impact on digital literacy competencies, gender, location, and academic stream did. Urban participants performed better than their rural counterparts, male pre-service teachers showed greater competencies than females, and students in the Science stream outperformed their peers in the Arts stream. These trends were a reflection of larger social disparities in access to technology and chances to acquire digital skills.

There were obvious ramifications: attaining digital equity in education necessitated deliberate, focused interventions that addressed the sociocultural and structural factors preventing underprivileged groups from developing digital literacy. Rajasthan's teacher education institutions needed to implement evidence-based pedagogies for technology integration, prioritise digital literacy as a core competency, and establish supportive environments where all pre-service teachers, regardless of gender, location, or academic background, could acquire the digital competencies necessary for teaching in the twenty-first century.

Limitations and Future Research Directions

It is important to recognise the various limitations of this study. Despite being sufficient for statistical analysis, the sample size (N=80) was comparatively small considering the variety of Rajasthan's teacher education environment. Generalisability would be strengthened by future studies using bigger, more representative samples. Longitudinal studies that monitor the development of digital literacy across teacher education programs would offer deeper

insights into developmental trajectories and the efficacy of interventions, as the cross-sectional design only recorded competencies at one point in time.

Furthermore, self-reported competency assessments were used in this study. Future studies could include qualitative analyses of the factors that promote and hinder the development of digital literacy, performance-based evaluations, and observation of real technology use in the classroom. More thorough illumination of contextual factors would be provided by comparative studies across Indian states with differing degrees of development and digital infrastructure.

Notwithstanding these drawbacks, this study offered evidence-based guidance for practice and policy and significantly advanced our understanding of digital literacy among Rajasthani pre-service teachers. Making sure that all aspiring teachers had strong digital competencies was not only desirable but also necessary for educational equity and quality as education embraced digital modalities more and more.

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