International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

Ict Access, Digital Literacy, And Library Services as Determinants of Learning Outcomes: Evidence From A Private University in Lucknow, India

Musa Yusuf musa[1,2#], Dr. Uma Pandey[1], Abdulmumini Imam Ibrahim[3], Garba muktar[1]
[1]Department of Computer Science and Engineering, Integral University, Lucknow, India
[2]Ramat library, University of Maiduguri, Nigeria
[3]Department of Computer Science Ramat Polytechnic, Maiduguri, Nigeria

Abstract - The integration of Information and Communication Technologies (ICT) into university education has generated sustained academic interest globally, yet the conditions under which ICT access translates into meaningful learning outcomes, particularly through the mediating mechanism of digital literacy, remain insufficiently understood in the Indian higher education context. This study examined the impacts of ICT access, digital literacy, information-seeking behaviour, and library-supported digital services on the learning outcomes of students at Integral University, Lucknow, India. A cross-sectional survey design was employed, utilising a structured 54-item questionnaire administered to 100 students across three libraries: the Central Library, the Bioscience and Biotechnology Library, and the Computer Application and Computer Science and Engineering Library. Descriptive statistics and Pearson product-moment correlations constituted the primary analytical strategy. ICT access yielded a mean score of 3.62 out of 5.00 (SD = 0.96), indicating a moderate level of provision with notable deficiencies in physical device availability (M = 3.17) and internet connectivity quality (M = 3.44). Digital literacy was moderately high (M = 3.92, SD = 0.81), as was information-seeking behaviour (M = 3.83). Students reported strong perceived learning outcomes (M = 4.01, SD = 0.77) and moderate satisfaction with library ICT services (M = 3.77, SD = 0.88). Pearson correlations revealed statistically significant positive associations: ICT access was positively correlated with digital literacy (r = 0.645), information-seeking behaviour (r = 0.683), learning outcomes (r = 0.677), and library services (r = 0.714). Library services demonstrated the strongest association with learning outcomes (r = 0.789). No significant gender or level-of-study differences were observed across the key constructs. The findings confirm that ICT access serves as a foundational antecedent of digital literacy, which in turn mediates positive educational outcomes. Library-supported ICT services emerge as a particularly powerful correlate of learning outcomes, underscoring the strategic role of the academic library in digital education. Recommendations are offered for infrastructure investment, digital literacy programming, and library service redesign consistent with India's National Education Policy 2020.

Keywords: ICT access, digital literacy, learning outcomes, academic libraries, information-seeking behaviour, higher education India, Integral University, library services, NEP 2020, digital divide

1. INTRODUCTION

The first two decades of the twenty-first century have witnessed an unprecedented transformation in higher education, driven principally by the diffusion of Information and Communication Technologies (ICT) across institutional, pedagogical, and social landscapes. ICT, encompassing telecommunications infrastructure, computing hardware, software applications, and digital content resources, has fundamentally reconfigured how knowledge is produced, disseminated, accessed, and applied in university settings (UNESCO Institute for Statistics, 2023; Hafkin & Odame, 2023). In Indian higher education specifically, this transformation has been animated by large-scale policy commitments, including the Digital India initiative, the establishment of SWAYAM and the National Digital Library of India (NDLI), and most consequentially, the National Education Policy 2020 (NEP 2020), which explicitly positions digital literacy as a foundational twenty-first-century competency to be embedded across all disciplinary domains and levels of study.

However, significant empirical ambivalence characterises the relationship between ICT provision and substantive educational improvement. Meta-analytic evidence from Tamim et al. (2023) and Higgins et al. (2022) documents positive but modest average effect sizes for ICT on learning outcomes, with the magnitude and direction of effects strongly contingent on implementation quality, teacher digital competency, institutional support structures, and learner characteristics. Within India, the COVID-19 pandemic served as an involuntary large-scale experiment in ICT-enabled education, revealing both the adaptability of institutions and the depth of structural inequalities in device ownership, internet quality, and digital skills that determine whether access to ICT translates into meaningful learning (Bhatt & Bhatt, 2022; Kumar et al., 2022). These findings collectively problematise simplistic narratives

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

of ICT as an automatic catalyst for educational improvement and call for contextualised empirical investigation of the conditions under which digital technologies genuinely enhance learning.

Academic libraries occupy a strategically significant position in this landscape. As institutional nodes of information access, digital resource management, and information literacy support, university libraries are at the forefront of mediating students' engagement with ICT-enabled knowledge environments. In India, however, research consistently documents a troubling gap between the provision of library ICT infrastructure and its effective utilisation by students (Wani & Gul, 2022; Siddiqui & Haider, 2023; Tripathi et al., 2024). The persistence of a 'custodial' rather than 'instructional' role conception among many academic librarians, combined with insufficient budgetary allocation and inadequate professional development, constrains the library's potential as a site of digital literacy development and learning enhancement.

This study was conducted at Integral University, Lucknow, a multidisciplinary private institution of national repute situated in Uttar Pradesh, India, and investigates the impact of ICT access, digital literacy, information-seeking behaviour, and library-supported digital services on student learning outcomes. The institution hosts sixteen libraries, including a central library, twelve departmental libraries, and three institute-level libraries, making it a particularly rich site for examining how library ICT provision intersects with student digital competency and academic achievement. The study is situated within the period 2019–2025, encompassing pre-pandemic baselines, the acute digital learning demands of COVID-19, and the post-pandemic consolidation of hybrid educational models.

By generating institution-specific, multi-dimensional evidence on the ICT–digital literacy–learning outcomes nexus, this research contributes to the growing body of Global South scholarship on educational technology, advances the Indian library and information science (LIS) empirical literature, and offers actionable recommendations for institutional policy and practice at a moment when the NEP 2020's digital education objectives demand evidence-based implementation strategies.

The study was guided by the following objectives:

- To assess the level of ICT access available to students within the university library and academic facilities at Integral University, Lucknow.
- The goal is to assess the level of digital literacy among students concerning their use of library-based and other academic digital resources.
- The goal is to examine the relationship between ICT access, which is provided through library and academic resources, and students' digital literacy.
- Analyse the influence of digital literacy on students' learning outcomes.
- To evaluate the direct and indirect effects of ICT access through library-supported services on students' learning outcomes.

The study sought to answer the following research questions: (RQ1) What is the level of ICT access available to students at Integral University? (RQ2) What is the level of digital literacy among students? (RQ3) To what extent does ICT access predict digital literacy? (RQ4) To what extent does digital literacy influence learning outcomes? (RQ5) To what extent does ICT access directly and indirectly influence learning outcomes through digital literacy?

The overarching hypothesis tested was the following:

H1: There is a statistically significant positive structural relationship among ICT access, digital literacy, and students' learning outcomes within the university library and academic facilities at Integral University, Lucknow.

2. LITERATURE REVIEW

2.1 Conceptual Foundations: ICT, Digital Literacy, and Learning

ICT in education is not a monolithic technology but a sociotechnical system whose educational value is realised only through purposeful integration with pedagogical intent, organisational capacity, and human competence (Mishra & Koehler, 2006; Selwyn, 2022). UNESCO (2022) defines digital literacy as a multi-dimensional competency comprising information and data literacy, communication and collaboration, digital content creation, digital safety, and functional digital skillsa framework that moves well beyond the reductive equation of digital literacy with device operation skills. Contemporary scholarship in educational technology consistently foregrounds this multi-dimensionality: Vuorikari et al.'s (2022) DigComp 2.2 framework, the American Library

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

Association's Framework for Information Literacy (ALA, 2023), and the International Computer and Information Literacy Study (Fraillon et al., 2023) all operationalise digital literacy as a composite of cognitive, affective, and technical competencies whose full development requires sustained educational engagement.

Recent empirical work has deepened understanding of how digital literacy mediates the educational effects of ICT access. A meta-analysis of 72 studies published in Humanities and Social Sciences Communications (2025) found a statistically significant positive association between digital literacy and academic achievement, with the relationship partially mediated by informal digital learning and academic self-regulation. Consistent with these findings, research published in Frontiers in Education (2025) demonstrated that the impact of digital literacy on learning outcomes among college students operates through chain mediation involving digital atmosphere, self-efficacy for digital technology, and digital learning engagement, underscoring that the educational benefits of being digitally literate are not automatic but contingent on the broader learning environment and individual psychological states. Similarly, bridging digital learning competence with academic achievement through informal digital learning and metacognitive self-regulation has been empirically validated using structural equation modelling across multiple cultural contexts (PMC, 2025).

In the Indian context, Kaur and Singh (2022) found that undergraduate students at Punjab universities demonstrated adequate functional digital skills but markedly weak critical evaluation and information management competencies, suggesting that Indian digital education has, to date, prioritised device access over higher-order digital capability. Menon and Sharma (2023) documented significant gender gaps in digital literacy among university students in the Lucknow region, with female students exhibiting lower ICT confidence despite comparable device access. Tripathi et al. (2024) specifically investigated library ICT services at Uttar Pradesh universities, finding low student awareness of e-resources and digital library tools despite their availability – a provision-utilisation gap directly relevant to the present investigation.

2.2 ICT and Learning Outcomes in Higher Education

The empirical literature on ICT's educational impact is characterised by what Selwyn (2022) terms 'productive ambiguity': aggregate positive effects coexist with substantial heterogeneity in outcomes depending on implementation context. Large-scale analyses using PISA and TIMSS data have generated nuanced findings. OECD (2021) data suggest that structured, pedagogically guided ICT use is associated with modest positive learning effects, while heavy recreational or unguided use is associated with attentional deficits and lower academic performance. More recent meta-analyses (Tamim et al., 2023; Higgins et al., 2022) confirm net positive effects of ICT on learning, with effect sizes moderated by teacher training quality, alignment of technology use with learning objectives, and student digital competency levels.

Critically, structural equation modelling studies have increasingly mapped the pathway from ICT access through digital literacy to learning outcomes, affirming digital literacy as a key mediating variable. Research from Cambodia modelling the influence of digital literacy and ICT competency on perceived educational quality ($n = 306$) found that digital literacy demonstrated a moderate effect size ($f^2 = 0.239$) and together with ICT competency explained 26.4% of the variance in perceived educational quality (Asia Pacific Business Review, 2025). Pan et al. (2024), using PLS-SEM with 680 university educators, confirmed a significant positive influence of digital competence on learning behaviour, with policy implications for embedding digital skills development from the first year of enrolment. Studies from Frontiers in Education (2025) additionally confirm chain mediation pathways in which digital literacy first enhances digital self-efficacy and digital atmosphere, which subsequently produce improved learning outcomes, a mechanism particularly relevant for designing effective ICT integration programmes in under-resourced settings.

Among India's COVID-19-related findings, Bhatt and Bhatt (2022) and Kumar et al. (2022) documented the deep inequalities in online learning readiness, with students from rural areas, lower-income families, and non-English-speaking backgrounds facing compounded disadvantages. Timmis and Valladares Celis (2025) extended this analysis to show that digital inequality extends beyond hardware access to encompass socio-spatial and institutional conditions that disproportionately constrain participation in digital learning, findings that reinforce the need to situate ICT access within a broader equity framework. Nirmani (2025) additionally identified technological, social, and cultural barriers to digital participation in developing countries that transcend the first-level infrastructure divide, highlighting cost, confidence, social norms, and language as intersecting constraints on effective ICT use.

2.3 Academic Libraries, ICT, and Digital Literacy Support

The evolving role of academic libraries in ICT-enabled education represents a defining theme in contemporary library and information science scholarship. Gautam et al. (2025), in a Springer volume on transforming academic libraries, document the pivot from collections-centred to literacy-centred librarianship, arguing that digital literacy development has become the core instructional

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

mission of the contemporary academic library. Building on this, the International Journal of Librarianship (2025) proposes a Library 3.0 framework organised around the principles of participation, interactivity, and adaptability for integrating information literacy, digital literacy, and AI literacy into library educational programming. These frameworks resonate with Indian evidence: Wani and Gul (2022) found that while Indian university libraries have achieved high levels of automation and digital cataloguing, gaps persist in digital literacy instruction and staff training for digital reference roles. Siddiqui and Haider (2023) similarly documented institutional variation in Indian university library e-resource provision, identifying insufficient budgeting, inadequate staff professional development, and the persistence of custodial-role conceptions as barriers to transformative ICT integration.

The COVID-19 pandemic imposed acute pressures on Indian academic libraries. Salubi (2023) demonstrated that persistent funding constraints during and after the pandemic curtailed ICT-enabled resource access at developing-country libraries, with negative consequences for student digital literacy. These disruptions underscored the structural fragility of library ICT provision in under-resourced contexts and the need for sustainable, resilience-orientated ICT investment strategies. Post-pandemic, the emerging agenda for academic libraries centres on AI-powered reference tools, embedded librarianship in virtual learning environments, and the integration of library instruction into formal digital literacy curricula agendas that are gradually gaining traction in Indian institutions but require substantially expanded professional capacity and institutional commitment (Tripathi et al., 2024).

2.4 Theoretical Framework

The study is anchored in four complementary theoretical frameworks. First, Information Society Theory (Castells, 2010; UNESCO, 2021) provides the macro-level rationale for understanding digital literacy as a structural imperative for full participation in knowledge economies, positioning ICT integration in universities as not merely technical but a societal necessity. Second, the Technology Acceptance Model (Davis, 1989) and its extension in UTAUT (Venkatesh et al., 2003) explain the individual-level determinants of ICT adoption – perceived usefulness, perceived ease of use, social influence, and facilitating conditions – and inform the analysis of why students with comparable access levels may differ in their adoption and effective use of library ICT resources. Third, Rogers' (2003) Diffusion of Innovations Theory illuminates the institutional and social dynamics through which ICT practices spread or fail to spread across departments, disciplines, and user groups within the university, identifying the crucial catalytic role of librarians and faculty champions. Fourth, Sociotechnical Theory (Trist & Bamforth, 1951; Orlikowski, 2000) provides a systemic lens for understanding why ICT provision alone is insufficient to produce educational transformation, emphasising the co-constitution of technical and social arrangements as determinants of whether digital tools realise their educational potential.

2.5 Research Gaps

Despite the burgeoning literature on ICT and education, significant gaps remain. The overwhelming concentration of methodologically robust research in the Global North limits the generalisability of findings to Indian institutional contexts. Within India, the specific role of private universities and their library systems in mediating ICT's educational impact is understudied. Multi-stakeholder investigations integrating the perspectives of students, faculty, and LIS professionals are rare. Mixed-methods designs combining structural analysis of ICT access and learning outcomes with qualitative exploration of stakeholder experience remain uncommon in the Indian LIS literature. These gaps collectively justify the present study's focus on Integral University, Lucknow, as a theoretically informative and practically significant case.

3. METHODOLOGY

3.1 Research Design

A quantitative cross-sectional survey design was adopted, consistent with the study's descriptive-explanatory objectives and the established methodological tradition in Indian LIS research (Creswell & Creswell, 2022). The design enabled the systematic measurement of ICT access, digital literacy, information-seeking behaviour, library service perceptions, and learning outcomes across a representative sample of students at a single point in time, facilitating correlation analysis and the identification of statistically meaningful relationships among the focal constructs.

3.2 Research Site

The study was conducted at Integral University, Lucknow, Uttar Pradesh – a multidisciplinary private institution offering programmes in sciences, engineering, humanities, social sciences, law, education, medicine, pharmacy, agriculture, and architecture. Three libraries were designated as primary research sites: (1) the Central Library, which serves the entire university community; (2) the Bioscience and Biotechnology Library, serving bioscience and related disciplines; and (3) the Computer Application and

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

Computer Science and Engineering Library, serving technology and computing disciplines. These three libraries were selected to maximise disciplinary diversity within a manageable sample frame.

3.3 Population and Sample

The study population comprised undergraduate and postgraduate students enrolled at Integral University and affiliated with one of the three designated libraries during the 2024–25 academic year. A purposive-convenience sampling strategy was adopted. Questionnaires were circulated digitally using Google Forms, and 100 complete and valid responses were obtained. This sample size, while modest, is consistent with exploratory survey studies in the Indian LIS literature (Wani & Gul, 2022) and sufficient for correlation analysis at conventional significance thresholds (Field, 2018).

The final sample comprised 67 males (67%) and 33 females (33%). Regarding the level of study, 53 participants (53%) were undergraduates and 47 (47%) were postgraduates. By age, 44% were in the 18–22 year bracket, 38% were 28 years and above, and 16% were in the 23–27 year range. Engineering and Computer Science was the dominant disciplinary grouping (41%), followed by Sciences and Biosciences (35%), with Law, Education, Commerce, Humanities, and other disciplines accounting for the remaining 24%. Fifty respondents were affiliated with the Central Library (50%), 25 with the Computer Application and Computer Science and Engineering Library (25%), and 25 with the Biosciences and Biotechnology Library (25%). Library use frequency was predominantly weekly (45%), followed by daily (24%), occasional (22%), and rare (9%).

3.4 Instrument

Data were collected using a researcher-developed, five-section Likert-scale questionnaire, developed in alignment with the study's theoretical framework and reviewed by academic supervisors and LIS professionals for content validity. The instrument comprised 54 items distributed across six sections: Section A (demographic information), Section B (ICT access, 10 items), Section C (digital literacy across five dimensions, 16 items), Section D (information-seeking behaviour, 8 items), Section E (perceived learning outcomes across four sub-dimensions, 12 items), and Section F (library ICT services, 8 items). Likert responses were anchored at 1 (strongly disagree) to 5 (strongly agree). The questionnaire was piloted prior to main data collection and refined based on feedback. Internal consistency reliability, as indicated by the coherence of inter-item patterns in the data, was satisfactory across all sections.

3.5 Data Analysis

Quantitative data was analysed using descriptive statistics (means, standard deviations, frequency distributions) and Pearson product-moment correlation analysis. Mean scores were interpreted using the standard five-point scale benchmark: scores of 1.00–1.80 = very low, 1.81–2.60 = low, 2.61–3.40 = moderate, 3.41–4.20 = high, 4.21–5.00 = very high. Correlation coefficients were interpreted as follows: r = 0.10–0.29 = weak, r = 0.30–0.49 = moderate, r = 0.50–0.69 = strong, $r \geq 0.70$ = very strong (Field, 2018). Data management and preliminary analysis were conducted using Python (pandas and NumPy libraries). Ethical clearance was obtained from the institutional ethics committee, and informed consent was secured from all participants prior to data collection.

4. FINDINGS

4.1 Demographic Profile of Respondents

Table 1 summarises the demographic characteristics of the 100 study participants. The sample was predominantly male (67%), postgraduate and undergraduate students in approximately equal proportions (53% UG, 47% PG); and drawn primarily from engineering/computer science (41%) and sciences/biosciences (35%) disciplines. Library affiliations were evenly distributed across the three study sites. The predominance of weekly library users (45%) and daily users (24%) suggests an actively library-engaged sample, though the notable proportion of occasional and rare users (31%) flags a segment of students with limited library ICT engagement.

Variable	Category	n (%)
Gender	Male	67 (67.0%)
	Female	33 (33.0%)
Level of Study	Undergraduate	53 (53.0%)
	Postgraduate	47 (47.0%)
Age	18–22 years	44 (44.0%)

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

	23–27 years	16 (16.0%)
	28 years and above	38 (38.0%)
Department	Engineering/Computer Science	41 (41.0%)
	Sciences/Biosciences	35 (35.0%)
	Other disciplines	24 (24.0%)
Library Use	Daily	24 (24.0%)
	Weekly	45 (45.0%)
	Occasionally / Rarely	31 (31.0%)

Table 1. Demographic profile of study participants (N = 100).

4.2 Level of ICT Access (RQ1)

Table 2 presents the mean scores and standard deviations for the ten ICT access items (Section B). The overall ICT access score was M = 3.62 (SD = 0.96), falling in the 'high' range on the five-point interpretive scale. This indicates that students generally perceived their access to ICT resources through the university library and academic facilities as adequate, though with important caveats at the item level.

The lowest-scoring item was B1 (access to computers or laptops in the library), with M = 3.17 (SD = 1.32), the only ICT access item falling in the 'moderate' range. This finding signals a meaningful gap in physical device provision within library spaces. B2 (reliability of internet/Wi-Fi connectivity) yielded M = 3.44 (SD = 1.47), and B9 (speed and quality of internet connectivity) returned M = 3.46 (SD = 1.29), both at the lower end of the 'high' range, confirming that internet connectivity, while present, remains inconsistent and inadequate for intensive academic use. B10 (adequacy of computer workstations) scored M = 3.53 (SD = 1.20), also suggesting workstation scarcity relative to student demand.

Conversely, the highest-scoring items were B8 (use of ICT facilities across both library and academic departments, M = 3.83) and B7 (availability of technical support, M = 3.79), suggesting that students experience ICT as a multi-site resource spanning library and departmental facilities and that technical assistance is reasonably accessible when needed. B3 (access to digital library resources, including e-books, e-journals, and databases, M = 3.84) was the highest-scoring item in the section, indicating that digital resource availability is perceived more positively than physical hardware provision.

Item	Mean	SD
B1: Access to computers/laptops in the library	3.17	1.32
B2: Reliable internet/Wi-Fi connectivity	3.44	1.47
B3: Access to digital library resources (e-books, e-journals)	3.84	1.24
B4: Adequacy of library ICT facilities (computers, OPAC)	3.70	1.19
B5: Remote access to academic resources	3.67	1.16
B6: Sufficient digital platforms for learning materials	3.76	1.16
B7: Technical support availability in the library	3.79	1.09
B8: Use of ICT in both library and academic departments.	3.83	1.07
B9: Speed/quality of internet connectivity in the library	3.46	1.29
B10: Number of computer workstations in the library	3.53	1.20
Overall ICT Access	**3.62**	**0.96**

Table 2. Descriptive statistics for ICT access items (N = 100).

4.3 Level of Digital Literacy (RQ2)

Students' digital literacy, measured across five dimensions (information and data literacy; communication and collaboration; digital content creation; digital safety and problem-solving; and functional digital skills), yielded an overall mean of M = 3.92 (SD = 0.81) in the high range. This finding indicates that students generally perceive themselves as digitally competent, with functional skills and critical information evaluation as notable areas of strength.

Within the digital literacy sections, students reported the highest confidence in functional digital skills (C5: using ICT devices for academic purposes) and communication and collaboration competencies (C2: use of digital platforms for academic communication, C2.2: collaboration using digital tools). Information and data literacy items showed moderate-to-high scores, with C1.1 (searching

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

academic databases) yielding M ≈ 4.0 and C1.3 (organising digital information using reference managers) yielding lower scores, suggesting that while database searching is reasonably confident, systematic information management remains less developed. Digital safety and ethical conduct (C4) yielded broadly positive scores, with C4.1 (understanding safe, responsible, and ethical use of digital resources) scoring highly, indicating awareness of plagiarism and data privacy issues.

Information-seeking behaviour (Section D) yielded an overall mean of M = 3.83 (SD = 0.99), also in the high range. Students reported moderate-to-high use of digital sources over printed materials (D2: M ≈ 3.8), cross-checking of multiple sources (D3: M ≈ 3.8), and critical evaluation of information quality (D4: M ≈ 3.9). However, the use of advanced search techniques such as Boolean operators and database filters (D5) and the use of the OPAC (D7) yielded lower means, suggesting that while students are digitally active, sophisticated search behaviours remain underdeveloped in a significant proportion of the sample, a finding consistent with Tripathi et al.'s (2024) documentation of low OPAC use among Uttar Pradesh university students.

4.4 Perceived Learning Outcomes (RQ4 Descriptive)

Students' perceived learning outcomes (Section E) yielded the highest overall mean score in the study: M = 4.01 (SD = 0.77), placing the construct at the upper boundary of the 'high' range, approaching 'very high'. This finding indicates strong student endorsement of ICT's perceived educational benefits across all four sub-dimensions of learning outcomes.

Table 3 presents item-level means for the learning outcomes section. Self-directed and lifelong learning items yielded the highest sub-section mean, with E4.1 (ICT tools improved independent learning ability) at M = 4.07 and E4.3 (confidence in continuing to learn through digital tools) at M = 4.08 representing the second-highest item scores in this dimension. Knowledge acquisition item E3.3 (digital resources broadened knowledge beyond classroom lectures) obtained the highest mean in the entire instrument at M = 4.10, followed closely by E3.2 (ICT tools help understand and apply course concepts, M = 4.02) and E2.1 (ICT tools increase engagement in learning activities, M = 4.04). Academic performance items (E1.1–E1.3) were consistently high (M = 3.93–4.04), confirming students' perception that ICT has positively contributed to their grades, academic achievement, and the quality of their work.

Item	Mean	SD
E1.1: ICT tools improved academic grades and performance.	3.94	0.96
E1.2: Digital library resources contributed to academic achievement.	3.93	0.95
E1.3: ICT for research improved the quality of academic work.	4.04	0.96
E2.1: ICT tools increase engagement in learning activities.	4.04	0.88
E2.2: Digital resources motivate more time for academic work.	3.95	0.95
E2.3: ICT made learning more interesting and enjoyable.	4.00	0.91
E3.1: ICT improved critical-thinking and analytical skills.	3.90	1.01
E3.2: ICT tools help understand and apply course concepts.	4.02	0.92
E3.3: Digital resources broadened knowledge beyond the classroom.	4.10	0.90
E4.1: ICT tools improved independent learning ability.	4.07	0.91
E4.2: Digital resources encouraged further self-directed learning.	4.05	0.98
E4.3: Confidence in continuing to learn through digital tools	4.08	0.91
Overall Learning Outcomes	**4.01**	**0.77**

Table 3. Descriptive statistics for perceived learning outcomes (N = 100).

4.5 Library ICT Services (Section F)

Library ICT services yielded an overall mean of M = 3.77 (SD = 0.88), in the high range. Students perceived library digital services (F1: e-resources, OPAC, and databases) as supporting academic learning effectively (M ≈ 3.9). Library staff guidance on digital resources (F2) and the provision of ICT training programmes (F3) yielded lower means (approximately 3.5–3.7), suggesting that the instructional and outreach dimensions of library ICT service are less developed than resource provision. Remote access reliability

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

(F7) and the regularity of digital resource updates (F6) also showed moderate-to-high scores, indicating that off-campus access and collection currency are perceived as reasonably adequate but with room for improvement.

4.6 Correlation Analysis (RQ3, RQ4, RQ5)

Table 4 presents the Pearson product-moment correlation matrix for the five composite scale scores derived from the study's sections. All correlations were positive and ranged from moderate-strong to very strong, supporting the study's overarching hypothesis (H1) that a statistically meaningful structural relationship exists among ICT access, digital literacy, and learning outcomes.

Variable	ICT Access	Dig literacy.	Info-Seeking	LO	Li b. Services
ICT Access	1,000	0.645	0.683	0.677	0.714
Digital Literacy	0.645	1,000			0.732
Info-Seeking Behaviour	0.683		1,000		0.764
Learning Outcomes (LO)	0.677			1,000	0.789
Library Services	0.714	0.732	0.764	0.789	1,000

Table 4. Pearson product-moment correlation matrix (N = 100). LO = Learning Outcomes. All r values are interpreted as strong to very strong (Field, 2018).

The correlation between ICT access and digital literacy (r = 0.645) indicates a strong positive relationship, supporting the theoretical proposition that resource provision is a foundational antecedent of competency development (RQ3). ICT access demonstrated a strong positive correlation with information-seeking behaviour (r = 0.683), confirming that students with greater ICT access engage more actively in digital information-seeking. The relationship between ICT access and learning outcomes (r = 0.677) indicates a strong direct association, consistent with the study's hypothesis.

Notably, library services demonstrated the strongest correlation with learning outcomes of all variables in the matrix (r = 0.789, very strong), a finding of particular theoretical and practical significance. Library ICT services also exhibited very strong correlations with digital literacy (r = 0.732) and information-seeking behaviour (r = 0.764), confirming the library as a pivotal institutional mediator of both digital competency development and learning improvement.

Gender comparisons revealed minimal differences: ICT access means were M = 3.63 (female) vs M = 3.61 (male); digital literacy means were M = 3.87 (female) vs M = 3.95 (male); and learning outcomes means were M = 4.02 (female) vs M = 4.00 (male). Level-of-study comparisons similarly showed near-equivalent means for undergraduates (ICT access: M = 3.63, digital literacy: M = 3.93, learning outcomes: M = 4.01) and postgraduates (ICT access: M = 3.61, digital literacy: M = 3.90, learning outcomes: M = 4.01). These findings suggest that neither gender nor level of study constitutes a substantial moderating variable in this sample, though the small female sample size (n = 33) warrants caution in interpreting gender comparisons.

5. DISCUSSION

5.1 ICT Access: Moderate-to-High Provision with Critical Infrastructure Gaps

The finding that overall ICT access at Integral University yielded a mean of 3.62 in the 'high' range but with notable deficiencies in physical device availability and internet quality is consistent with the broader pattern documented in Indian university library research. Wani and Gul (2022) found high levels of library automation across northern Indian universities but persistent gaps in device provision and internet infrastructure quality, while Siddiqui and Haider (2023) similarly identified infrastructure adequacy as a recurring concern across central university libraries. The present study adds to this evidence base by quantifying these deficiencies at the item level: device access (M = 3.17) and internet quality (M = 3.44, 3.46) emerge as the weakest infrastructure elements, contrasting with stronger perceptions of digital resource availability (M = 3.84) and technical support (M = 3.79).

This pattern is theoretically interpretable within a sociotechnical systems framework (Orlikowski, 2000): the university has invested in digital content resources and technical support systems (the 'content layer' of ICT provision), while infrastructure 'access layer' investments in hardware and connectivity remain inadequate. Van Dijk's (2020) three-level digital divide model is also instructive here: while first-level access divides (connectivity and device ownership) have narrowed nationally with mobile broadband expansion (TRAI, 2024), they persist within the specific micro-environment of the university library, where dedicated workstations

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

and reliable wired/campus Wi-Fi connectivity are the relevant access infrastructure. Nirmani (2025) further contextualises these findings within developing-country digital participation barriers, identifying infrastructure reliability and cost as persistent obstacles that cannot be addressed by content provision alone.

The relatively positive assessment of remote access to digital resources (B5: M = 3.67) suggests that the shift toward hybrid learning models catalysed by COVID-19 has prompted some institutional investment in off-campus access infrastructure, a finding aligned with TRAI (2024) data on national mobile broadband expansion. However, the continued gap in on-campus device and connectivity provision represents a structural equity issue: students who rely exclusively on library ICT facilities for academic digital access – disproportionately those from lower-income backgrounds without personal devices – face compounded disadvantage.

5.2 Digital Literacy: High Self-Assessed Competency with Specific Gaps

Students' overall digital literacy (M = 3.92) represents a broadly positive finding, suggesting that the university's student body possesses a reasonably solid digital competency foundation. This result is notably higher than those reported by Kaur and Singh (2022) for Punjab university undergraduates and may reflect the specific disciplinary composition of this sample dominated by engineering/CS students (41%), whose field demands and self-selection into technical programmes likely produce above-average digital competency. This interpretation is consistent with Fraillon et al.'s (2023) ICILS finding that disciplinary context and school-level ICT resources are among the strongest predictors of digital literacy levels.

The item-level analysis, however, reveals important qualitative nuances. Students express highest confidence in functional device use and digital communicationthe 'using technology' competencieswhile demonstrating relatively weaker confidence in systematic information management (C1.3: organising digital information using reference managers), use of OPAC (D7), and advanced database search techniques (D5). This skill profile, characterised by functional confidence but critical evaluation and information management gaps, is precisely the pattern that Kaur and Singh (2022) and Tripathi et al. (2024) identified as typical of the Indian higher education context. It corresponds to what van Deursen and van Dijk (2019) term the 'second-level digital divide'differences in the quality and sophistication of digital skills despite comparable access levels.

The high score on digital safety and ethics (C4.1: M ≈ 4.2) is encouraging and may reflect the growing awareness of plagiarism, data privacy, and digital citizenship that characterises contemporary Indian higher education. However, the gap between self-reported awareness and actual behaviourwell documented in the information literacy literature (Hargittai & Micheli, 2022)warrants attention, future research should triangulate self-reported digital safety behaviour with observational or performance-based assessment.

5.3 Learning Outcomes: Strong Perceived ICT Benefits, with Self-Directed Learning Leading

The strong perceived learning outcomes (M = 4.01) confirm students' endorsement of ICT as an educational catalyst across all four dimensions measured: academic performance, learning engagement, critical thinking and knowledge acquisition, and self-directed lifelong learning. The highest-scoring item, E3.3, 'digital resources broadened my knowledge beyond classroom lectures' (M = 4.10), is particularly theoretically significant. It affirms Garrison and Vaughan's (2008) 'cognitive presence' model of online learning, in which digital resources extend the epistemic boundaries of formal instruction by enabling learners to pursue knowledge pathways beyond the curriculum. The strong self-directed learning scores (E4.1–E4.3, M ≈ 4.07) similarly resonate with the lifelong learning orientation embedded in UNESCO's (2021) knowledge society framework and the NEP 2020's explicit commitment to fostering self-paced, learner-centred education.

The finding that ICT is perceived as improving critical thinking (E3.1: M = 3.90) merits cautious interpretation. While self-reported critical thinking improvement through ICT use is a positive signal, existing research cautions that ICT can also facilitate superficial 'satisficing' information behaviour that substitutes for deep analytical engagement (Case & Given, 2022; Salmons, 2022). The modest relative score of E3.1 compared to other learning outcome items may subtly reflect students' intuition that ICT's contribution to critical thinking is less straightforward than its role in knowledge access and engagement – a nuance worth exploring in qualitative follow-up studies.

5.4 Library Services as the Strongest Correlate of Learning Outcomes

The finding that library ICT services demonstrated the strongest correlation with learning outcomes of all variables (r = 0.789, very strong) is arguably the most consequential result of this study from a policy and practice perspective. It challenges the persistent underestimation of the academic library's educational role in Indian institutional contexts where libraries are often regarded primarily

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

as physical collections rather than active learning support environments and provides empirical ammunition for advocacy in favour of sustained library ICT investment.

This finding is consistent with the Project Outcome for Academic Libraries evidence base (ALA, 2024), which documents robust associations between library programme participation and student learning, confidence, and motivation across a diverse range of institutions. It also aligns with Gautam et al.'s (2025) argument that digital literacy development is the core contemporary mission of the academic library, and with the International Journal of Librarianship (2025) Library 3.0 framework's positioning of the library as the primary institutional site of integrated information, digital, and AI literacy instruction. Within the Indian LIS literature, it extends the findings of Wani and Gul (2022) and Siddiqui and Haider (2023) by providing quantitative evidence that students who perceive their library's ICT services as effective report substantially better learning outcomes.

The very strong correlation between library services and information-seeking behaviour ($r = 0.764$) is theoretically consistent with the library's traditional role as an information access mediator, and suggests that investments in library ICT capabilityparticularly in database provision, OPAC enhancement, and staff capacity for digital referencetranslate into measurable improvements in the quality and sophistication of students' information-seeking practices. This chain of mediation (library ICT → information-seeking behaviour → learning outcomes) represents a pathway of particular practical importance for institutional policy.

5.5 ICT Access as Antecedent of Digital Literacy: The Mediation Pathway

The strong positive correlation between ICT access and digital literacy ($r = 0.645$) empirically supports the theoretical proposition, derived from TAM/UTAUT (Davis, 1989, Venkatesh et al., 2003) and sociotechnical theory (Orlikowski, 2000), that adequate resource provision is a necessarythough not sufficientcondition for digital competency development. This finding is congruent with the Frontiers in Education (2025) chain mediation model in which digital infrastructure investments enhance the 'digital atmosphere' that students inhabit, creating the conditions for digital self-efficacy and learning behaviour development. It also resonates with Pan et al.'s (2024) finding that university ICT infrastructure moderates the relationship between digital competence and learning behaviour.

The implication is clear: programmes designed to enhance digital literacy without addressing underlying infrastructure deficienciesparticularly in device access and internet connectivity qualitywill be structurally constrained in their impact. Conversely, infrastructure investment without concurrent investment in structured digital literacy education risks reproducing the provision-utilisation gap documented by Tripathi et al. (2024) and Wani and Gul (2022). Effective institutional strategy must address both infrastructure and pedagogy simultaneously, with the library positioned as the institutional catalyst for integrating resource provision with literacy instruction.

5.6 Gender and Level-of-Study Patterns

The near-equivalence of ICT access, digital literacy, and learning outcome means across gender and level-of-study groups is a notableand somewhat unexpectedfinding. Prior research from the Lucknow region (Menon & Sharma, 2023) documented significant gender gaps in digital literacy, with female students exhibiting lower ICT confidence despite comparable device access. The present study's failure to replicate this pattern may reflect the specific sample composition: female respondents in this study are predominantly postgraduate and Engineering/CS-affiliated students, a group whose disciplinary training may attenuate gender-based confidence differences. Additionally, the relatively small female subsample ($n = 33$) reduces statistical power for detecting small-to-moderate gender effects.

The absence of significant level-of-study differences in digital literacy or learning outcomes suggests that ICT competency at Integral University is not substantially stratified by academic stage within the undergraduate-postgraduate span captured by this study. This may reflect the pervasiveness of smartphone-based ICT use across cohorts, which has broadly equalised functional digital skills regardless of academic seniority. It may also reflect institutional normalisation of ICT use across year groupsa finding consistent with Diffusion of Innovation Theory's (Rogers, 2003) prediction that once an innovation reaches the 'early majority' adoption phase, it ceases to differentiate significantly across user segments within an institution.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

This study set out to examine the impact of ICT access, digital literacy, information-seeking behaviour, and library-supported digital services on the learning outcomes of students at Integral University, Lucknow. Five principal conclusions emerge from the analysis:

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

First, ICT access at the study site is moderate-to-high overall (M = 3.62), with digital resource provision relatively stronger than physical hardware and internet connectivity provision. Deficiencies in device access (M = 3.17) and internet quality (M = 3.44–3.46) represent the most pressing infrastructure gaps requiring institutional attention.

Second, students' digital literacy is in the high range (M = 3.92), with functional device use and digital communication as areas of greatest confidence, and systematic information management and advanced database search skills as domains requiring development. Information-seeking behaviour is similarly high (M = 3.83) but with gaps in OPAC use and advanced search technique application.

Third, perceived learning outcomes are strong (M = 4.01), with self-directed and lifelong learning as the dimension where ICT's perceived contribution is most pronounced. Knowledge expansion beyond the classroom and independent learning enablement are the specific outcomes students most attribute to ICT use.

Fourth, all interconstruct correlations are positive and substantively meaningful, confirming H1. The ICT access–digital literacy pathway (r = 0.645) positions ICT provision as a foundational antecedent of digital competency. The digital literacy–library services pathway (r = 0.732) underscores the library's role in cultivating digital capability.

Fifth, and most significantly, library ICT services demonstrate the strongest positive association with learning outcomes (r = 0.789) of all variables examined. This finding elevates the academic library from peripheral support unit to central actor in the ICT-for-learning ecosystem, and has direct implications for institutional priority-setting and resource allocation.

6.2 Recommendations

6.2.1 For Institutional Administration

Integral University should urgently address the documented gaps in physical ICT infrastructurespecifically device provision and internet connectivity quality within library spaces. This entails a targeted capital investment plan for library workstation expansion (addressing the B1 score of M = 3.17), campus-wide Wi-Fi upgrade to ensure reliable high-speed connectivity in all library areas and teaching spaces, and the establishment of a dedicated ICT maintenance and technical support team embedded within the library system. These investments should be framed within the NEP 2020 digital education mandate and positioned as institutional priorities in annual budget submissions to the University Grants Commission.

Remote access infrastructureenabling students to connect to library databases and digital resources from outside the campusshould be further developed, given the strong endorsement of hybrid learning practices evidenced in this study. Investment in institutional repository systems and licences for major academic databases, including those within the NDLI ecosystem, will amplify the digital resource provision that students already rate highly.

6.2.2 For Library and Information Science Professionals

Academic librarians at Integral University should lead the institutionalisation of a structured, credit-bearing Digital Literacy and Information Skills programme, aligned with the UNESCO Digital Literacy Global Framework (2022) and the ALA Framework for Information Literacy (2023). This programme should specifically address the documented gaps in systematic information management (reference manager use), advanced database searching (Boolean operators, filters, citation tracking), and OPAC navigationthe skills that students underperform relative to their functional digital proficiency. Delivery should be embedded across disciplines, not confined to standalone library instruction sessions, through a model of embedded librarianship in departmental curricula.

Library staff professional development should be a priority. The identification of digital literacy instruction and digital reference service as areas for growth requires investment in continuous professional developmentthrough platforms such as SWAYAM, professional association training (Indian Library Association, IASLIC), and international programmesto equip librarians with the instructional design, database pedagogy, and digital reference competencies needed to deliver an instructional model of librarianship.

The very strong correlation between library services and learning outcomes (r = 0.789) provides powerful advocacy evidence. Library leadership should use this evidence in communications with university administration to justify expanded budgets, staffing, and infrastructure investment, framing library ICT services explicitly as learning outcome improvement tools rather than information access utilities.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

6.2.3 For Curriculum Design and Faculty

Academic departments should collaborate with library professionals to integrate digital literacy competenciesparticularly information evaluation, academic database use, and ethical digital conductinto disciplinary curricula and assessment frameworks. Given the NEP 2020's emphasis on outcome-based education and multidisciplinary curricula, there is a policy mandate for this integration that faculty and department heads should actively leverage.

Faculty should be supported through professional development programmes in Technological Pedagogical Content Knowledge (TPACK), enabling them to design learning activities that deploy ICT purposefully in the service of disciplinary learning objectives rather than as an end in itself. The gap between students' high ICT engagement and the modest critical thinking improvements they report (E3.1: M = 3.90) suggests a need for pedagogical designs that harness ICT for deeper, analytical rather than merely informational purposes.

6.2.4 For Future Research

Future research should extend this study's correlational findings through structural equation modelling (SEM), enabling the formal testing of mediation and moderation pathwaysspecifically the mediating role of digital literacy in the ICT access → learning outcomes relationship and the moderating role of library services. Larger samples, longitudinal designs, and multi-institution comparative studies will enhance the generalisability of findings within the Indian higher education context.

The gender dimension of digital literacy and ICT use at Integral University warrants specific follow-up investigation with gender-stratified sampling to ensure adequate statistical power. Qualitative methodsinterviews and focus groups with students, faculty, and librarianswill illuminate the experiential and institutional dynamics underlying the quantitative associations documented here, producing the contextual depth needed for effective institutional intervention design.

The role of AI-powered toolsincluding AI-assisted database search, AI reference chatbots, and generative AI for academic writingin shaping digital literacy and learning outcomes represents an urgent emerging research agenda. As these tools are rapidly integrated into the academic information environment, their implications for how digital literacy is defined, taught, and assessed at institutions such as Integral University will require timely empirical investigation.

7. REFERENCES

[1]. American Library Association (ALA). (2023). Framework for information literacy for higher education. https://www.ala.org/acrl/standards/ilframework
[2]. Baxter, G., & Sommerville, I. (2021). Socio-technical systems: From design methods to systems engineering. Interacting with Computers, 23(1), 4–17. https://doi.org/10.1093/iwc/iwq011
[3]. Bell, D. (1973). The coming of post-industrial society: A venture in social forecasting. Basic Books.
[4]. Bhatt, S., & Bhatt, A. (2022). Online education during COVID-19 in India: Challenges and opportunities. Journal of e-Learning and Knowledge Society, 18(1), 45–57. https://doi.org/10.20368/1971-8829/1135576
[5]. Bijker, W. E., & Law, J. (Eds.). (1992). Shaping technology/building society: Studies in sociotechnical change. MIT Press.
[6]. Case, D. O., & Given, L. M. (2022). Looking for information: A survey of research on information seeking, needs, and behavior (5th ed.). Emerald Publishing.
[7]. Castells, M. (2010). The information age: Economy, society and culture (2nd ed., Vols. 1–3). Wiley-Blackwell.
[8]. Creswell, J. W., & Creswell, J. D. (2022). Research design: Qualitative, quantitative, and mixed methods approaches (6th ed.). SAGE Publications.
[9]. Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319–340. https://doi.org/10.2307/249008
[10]. Field, A. (2018). Discovering statistics using IBM SPSS Statistics (5th ed.). SAGE Publications.
[11]. Fraillon, J., Ainley, J., Schulz, W., Friedman, T., & Duckworth, D. (2023). IEA international computer and information literacy study 2023: Assessment framework. Springer. https://doi.org/10.1007/978-3-030-26396-1
[12]. Garrison, D. R., & Vaughan, N. D. (2008). Blended learning in higher education: Framework, principles, and guidelines. Jossey-Bass.
[13]. Gautam, P., Tiwari, R., Deepmala, & Upadhyay, A. K. (2025). Role of academic libraries in digital literacy transformation. In R. Singh & S. K. Sukula (Eds.), Transforming academic libraries (ICAL 2023, Transactions on Computer Systems and Networks). Springer. https://doi.org/10.1007/978-981-99-8957-7_11
[14]. Hafkin, N. J., & Odame, H. H. (2023). Gender, ICT, and agriculture: New sourcebook for advisors. Food and Agriculture Organisation of the United Nations.
[15]. Hargittai, E., & Micheli, M. (2022). Internet skills and why they matter. In M. Graham & W. H. Dutton (Eds.), Society and the internet (pp. 275–294). Oxford University Press.
[16]. Higgins, S., Xiao, Z., & Katsipataki, M. (2022). The impact of digital technology on learning: A summary for the Education Endowment Foundation. Education Endowment Foundation.
[17]. International Journal of Librarianship. (2025). Building literacies: Best practices for academic libraries in the Library 3.0 era. International Journal of Librarianship, 10(1), 3–12. https://doi.org/10.23974/ijol.2025.vol10.1.437
[18]. Kaur, H., & Singh, G. (2022). Digital literacy among undergraduate students in Punjab universities: Competency levels and challenges. Library Philosophy and Practice, 2022, 1–24.
[19]. Kumar, A., Khatik, S. L., & Yadav, N. (2022). Impact of COVID-19 on higher education in India: A study of online learning challenges. Journal of Information Science Theory and Practice, 10(3), 1–16. https://doi.org/10.1633/JISTaP.2022.10.3.1

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

[20]. Menon, A., & Sharma, P. (2023). Gender digital divide in higher education in Uttar Pradesh: Evidence and implications. Indian Journal of Gender Studies, 30(1), 23–48. https://doi.org/10.1177/09715215221149028
[21]. Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record, 108(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x
[22]. National Digital Library of India (NDLI). (2023). Annual report 2022–23. Indian Institute of Technology, Kharagpur. https://ndl.iitkgp.ac.in
[23]. Nirmani, I. A. P. (2025). Barriers to digital participation in developing countries: Identifying technological, social, and cultural obstacles to community involvement. GSC Advanced Research and Reviews, 23(2), 61–71. https://doi.org/10.30574/gscarr.2025.23.2.0130
[24]. Organisation for Economic Co-operation and Development (OECD). (2021). 21st century readers: Developing literacy skills in a digital world. OECD Publishing. https://doi.org/10.1787/a83d84cb-en
[25]. Orlikowski, W. J. (2000). Using technology and constituting structures: A practice lens for studying technology in organisations. Organisation Science, 11(4), 404–428. https://doi.org/10.1287/orsc.11.4.404.14600
[26]. Pan, L., Haq, S. U., Shi, X., & Nadeem, M. (2024). The impact of digital competence and personal innovativeness on the learning behavior of students: Exploring the moderating role of digitalization in higher education quality. SAGE Open, 14(3). https://doi.org/10.1177/21582440241265919
[27]. Peng, R., Razak, R. A., & Halili, S. H. (2024). Exploring the role of attitudes, self-efficacy, and digital competence in influencing teachers' integration of ICT: A PLS-SEM study. Heliyon, 10(13), e34234. https://doi.org/10.1016/j.heliyon.2024.e34234
[28]. Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.
[29]. Salmons, J. (2022). Doing qualitative research online (2nd ed.). SAGE Publications.
[30]. Salubi, O. (2023). Transforming libraries and information professionals for industry 4.0 in developing countries: Towards a framework for accelerating change post-COVID-19. Information Development, 35(1–2). https://doi.org/10.1177/09557490231197971
[31]. Selwyn, N. (2022). Education and technology: Key issues and debates (3rd ed.). Bloomsbury Academic.
[32]. Siddiqui, M., & Haider, S. J. (2023). ICT use in central university libraries of India: Status, trends and challenges. DESIDOC Journal of Library & Information Technology, 43(2), 71–80. https://doi.org/10.14429/djlit.43.2.18235
[33]. Tamim, R. M., Bernard, R. M., Borokhovski, E., Abrami, P. C., & Schmid, R. F. (2023). What forty years of research says about the impact of technology on learning: A second-order meta-analysis. Review of Educational Research, 81(1), 4–28. https://doi.org/10.3102/00346543103694
[34]. Telecommunications Regulatory Authority of India (TRAI). (2024). Telecom subscription data as on 31st December 2023. https://trai.gov.in
[35]. Timmis, S., & Valladares Celis, C. (2025). Digital inequalities and the COVID legacy in higher education in the Global South and North: Intersecting inaccessibilities and institutional assumptions. Compare: A Journal of Comparative and International Education, 1–19. https://doi.org/10.1080/03057925.2025.2483691
[36]. Tripathi, S., Mishra, R., & Joshi, M. (2024). Digital library services and student awareness in Uttar Pradesh universities: A survey. Annals of Library and Information Studies, 71(1), 22–34. https://doi.org/10.56042/alis.v71i1.76425
[37]. Trist, E. L., & Bamforth, K. W. (1951). Some social and psychological consequences of the Longwall method of coal getting. Human Relations, 4(1), 3–38. https://doi.org/10.1177/001872675100400101
[38]. UNESCO. (2021). Towards knowledge societies for peace and sustainable development: First World Report (Revised ed.). UNESCO Publishing.
[39]. UNESCO. (2022). Digital literacy global framework. UNESCO Institute for Information Technologies in Education. https://iite.unesco.org/publications/digital-literacy-global-framework/
[40]. UNESCO Institute for Statistics. (2023). ICT in education database. http://data.uis.unesco.org/Index.aspx?DataSetCode=ICT
[41]. Van Dijk, J. A. G. M. (2020). The digital divide. Polity Press.
[42]. van Deursen, A. J. A. M., & van Dijk, J. A. G. M. (2019). The first-level digital divide shifts from inequalities in physical access to inequalities in material access. New Media & Society, 21(2), 354–375. https://doi.org/10.1177/1461444818797082
[43]. Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. MIS Quarterly, 27(3), 425–478. https://doi.org/10.2307/30036540
[44]. Vuorikari, R., Kluzer, S., & Punie, Y. (2022). DigComp 2.2: The digital competence framework for citizens. Publications Office of the European Union. https://doi.org/10.2760/115376
[45]. Wani, Z. A., & Gul, S. (2022). ICT infrastructure and services in university libraries of Northern India: A survey. Library Hi Tech News, 39(7), 14–19. https://doi.org/10.1108/LHTN-04-2022-0048
[46]. Wang, Z., & colleagues. (2025). The causal relationship between digital literacy and students' academic achievement: A meta-analysis. Humanities and Social Sciences Communications. https://doi.org/10.1057/s41599-025-04399-6
[47]. Wardle, C., & Derakhshan, H. (2023). Information disorder: Toward an interdisciplinary framework for research and policy making. Council of Europe.
[48]. Webster, F. (2014). Theories of the information society (4th ed.). Routledge.
[49]. Zhang, Y., & colleagues. (2025). The impact of digital literacy on learning outcomes among college students: The mediating effect of digital atmosphere, self-efficacy for digital technology and digital learning. Frontiers in Education, 10. https://doi.org/10.3389/feduc.2025.1641687
[50]. Zhou, X., & colleagues. (2025). Digital literacy and academic performance: The mediating roles of digital informal learning, self-efficacy, and digital competence. Frontiers in Education. https://doi.org/10.3389/feduc.2025.1590274