

Digital Literacy as a Catalyst for Gender Equality in Sustainable Development: A Critical Review of Evidence, Interventions, and Policy Pathways

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Abstract

Digital literacy has emerged as a key determinant of who benefits from the digital transformation of economies and societies, and mounting evidence shows that these benefits are distributed unevenly along gender lines. This paper undertakes a critical, literature-based review of the relationship between digital literacy, the gender digital divide, and the gender equality goals embedded in the 2030 Agenda for Sustainable Development. Drawing on global datasets from the International Telecommunication Union and the GSMA, peer-reviewed scholarship on the gender digital divide, and documented digital-inclusion programs from India and elsewhere, the review synthesises evidence across four themes: the persistence and drivers of the gender digital divide; digital literacy as a mechanism of women's economic, educational, and civic empowerment; the design features that distinguish effective digital-literacy interventions; and the structural gaps that continue to limit impact at scale. The analysis indicates that access-focused policies alone are insufficient; disparities in skills, confidence, safety, and relevance to women's daily lives account for a large share of the residual gap even where connectivity has improved. The paper concludes with policy recommendations on affordability, gender-responsive curricula, safe digital environments, sex-disaggregated monitoring, and cross-sector partnerships. It identifies avenues for future primary research, including longitudinal and intersectional studies that current secondary literature cannot resolve.....

Keywords: digital literacy, gender digital divide, gender equality, sustainable development, digital inclusion, women's empowerment

Introduction

The rapid diffusion of digital technologies over the past two decades has reorganised how people access education, earn a livelihood, obtain public services, and participate in civic life. This transformation is often framed as an equalising force, yet substantial evidence shows that access to, and effective use of, digital technologies remains stratified by gender (Antonio & Tuffley, 2014; Singh et al., 2025). The gap has narrowed only slowly: the International Telecommunication Union (ITU, 2024) reports that in 2024, 70% of men and 65% of women worldwide used the internet, a gap that has been closing but still left 189 million more men than women online. The gap is markedly wider in low-income contexts; among least developed countries, only 29% of women used the internet in 2024, compared with 41% of men (ITU, 2025). Mobile-specific data tell a similar story: the GSMA's Mobile Gender Gap Report 2025 found that women in low- and middle-income countries were 14% less likely than men to use mobile internet, leaving 885 million women unconnected, with roughly 60% of them concentrated in South Asia and Sub-Saharan Africa (GSMA, 2025). The most recent edition of the same report shows the gap narrowing marginally to 12% in 2025, with 810 million women still offline (GSMA, 2026).

These statistics describe access, but access is only the first layer of a deeper problem. Scholars of the digital divide have long distinguished between a "first-level" divide in physical access to technology and a "second-level" divide in the skills, literacy, and confidence needed to use technology productively once access is available (Van Dijk, 2005, 2006). This second-level divide—digital literacy—increasingly determines whether connectivity translates into tangible benefits such as income, education, or political voice. Digital literacy can be defined as the

constellation of skills required to locate, evaluate, create, and communicate information safely and effectively using digital technologies, spanning technical operation, information evaluation, communication and collaboration, digital citizenship, and online safety (Law et al., 2018). Because these competencies must typically be learned rather than acquired automatically through access, they are also more susceptible to the influence of social norms, time poverty, educational disadvantage, and safety concerns that disproportionately affect women and girls (Antonio & Tuffley, 2014; Organisation for Economic Co-operation and Development [OECD], 2018). Gender equality is both a human right and Goal 5 of the United Nations' Sustainable Development Goals (SDGs), and it is explicitly cross-cutting across the other sixteen goals, from poverty eradication (SDG 1) to decent work (SDG 8) to reduced inequality (SDG 10) (United Nations, 2015). Digital literacy occupies an unusual position in this framework: it is itself the subject of an SDG indicator (4.4.2, on the proportion of youth and adults with at least a minimum level of digital literacy skill) and simultaneously a lever that, in principle, accelerates progress toward several other goals by expanding women's access to markets, information, and services (Law et al., 2018; United Nations, 2015). Whether that potential is realised in practice, however, depends on how digital-literacy policies and programs are designed, targeted, and evaluated — a question that requires bringing together strands of literature that have often been treated separately: digital-divide research, gender and development scholarship, and program evaluation of specific digital-inclusion initiatives.

This paper responds to that need through a critical review that synthesises what is currently known, rather than collecting new primary data. Three questions guide the review: (a) What does the existing evidence show about the scale and drivers of the gender gap in digital literacy? (b) Through which mechanisms does digital literacy contribute to women's empowerment and to sustainable development more broadly? (c) What features distinguish digital-literacy interventions that have demonstrated measurable reach and impact, and where do current efforts fall short? The remainder of the paper proceeds as follows. Section 2 reviews the conceptual and empirical literature on digital literacy, the gender digital divide, and their relationship to sustainable development. Section 3 sets out the review methodology. Section 4 presents a thematic synthesis of the evidence, including documented digital-literacy programs. Section 5 translates the synthesis into policy recommendations, and Section 6 concludes with limitations and directions for future primary research.

2. Literature Review

2.1 Digital Literacy: Conceptual Foundations

Definitions of digital literacy have evolved considerably since the term entered common use. Early formulations emphasised operational competence with hardware and software; more recent frameworks conceive of digital literacy as a multidimensional construct. The UNESCO-commissioned Digital Literacy Global Framework, developed to operationalise SDG Indicator 4.4.2, organises digital literacy into seven competence domains: device and software operation; information and data literacy; communication and collaboration; digital content creation; safety; problem-solving; and career-related competencies (Law et al., 2018). This framework is useful for the present review because it treats safety and critical evaluation as core competencies rather than an afterthought. This distinction matters for understanding why women's digital-literacy trajectories often diverge from men's even after initial access barriers are addressed. Van Dijk's (2005, 2006) resource-and-appropriation model similarly separates motivational access, physical access, skills access, and usage access, arguing that policy interventions focused solely on the first two stages will systematically understate — and fail to close — the gap that persists in the latter two.

2.2 Gender, Sustainable Development, and SDG 5

The 2030 Agenda frames gender equality as both a freestanding goal (SDG 5: achieve gender equality and empower all women and girls) and a cross-cutting condition for the other sixteen goals (United Nations, 2015). Feminist scholarship on technology has cautioned against treating digital tools as automatically empowering; Wajcman (2004) argued that technologies are shaped by, and in turn reproduce, the gendered social relations in which they are embedded, so that the benefits of a given technology cannot be assumed but must be examined empirically for each context and population. This caution is echoed in more recent systematic reviews: Singh et al. (2025) synthesised the literature on women's digital inclusion and concluded that structural, cultural, and institutional barriers interact in ways that require multi-level policy responses rather than single-lever interventions such as device distribution alone. The interlinkage between gender equality and sustainable

development is therefore not automatic; it depends on whether digital interventions are designed with an explicit gender lens, addressing not only connectivity but also the skills, safety, and social permission that determine whether women can convert access into outcomes.

2.3 The Gender Digital Divide: Evidence and Drivers

A substantial empirical literature documents both the scale and the causes of the gender digital divide. Antonio and Tuffley's (2014) widely cited review found that women in developing countries had significantly lower rates of technology participation than men, a pattern the authors attributed to entrenched socio-cultural expectations about women's roles, time poverty from domestic responsibilities, and lower educational attainment and income — conditions that limit both the opportunity and the confidence to acquire digital skills. Notably, Hilbert (2011), analysing datasets from twelve Latin American and thirteen African countries, found that once income, education, and employment status were statistically controlled for, women were, if anything, more active users of digital tools than men. This finding reframes the gender digital divide less as a matter of technological aptitude and more as a downstream consequence of the same socio-economic disadvantages that limit women's opportunities generally — a reframing with direct implications for policy, since it suggests that literacy interventions bundled with economic and educational support are likely to outperform technology-only interventions.

More recent institutional data corroborate the continued relevance of these structural drivers. The OECD's (2018) review for the G20 identified affordability, lower educational enrollment in science, technology, engineering, and mathematics (STEM) fields, and entrenched socio-cultural norms as the principal causes of gender-based digital exclusion, noting that women in developing regions were on average 26% less likely than men to own a smartphone. The World Bank's (2024) practical guide to closing gender gaps in digital development similarly documents that women are 17% less likely than men to own a smartphone and face compounding disadvantages in the identification and financial-account ownership that increasingly gate access to digital public services. The GSMA's Mobile Gender Gap Report 2025 found that these patterns persist despite years of dedicated programming, with progress in narrowing the mobile-internet gender gap in low- and middle-income countries slowing rather than accelerating in 2024 (GSMA, 2025); its 2026 edition recorded a modest improvement, with the gap narrowing to 12% and roughly 80 million additional women adopting mobile internet over the preceding year (GSMA, 2026). Taken together, this evidence base suggests that while the digital gender divide is neither fixed nor intractable, closing it requires sustained, multi-year investment rather than one-off connectivity programs.

Safety is another, less frequently quantified dimension of the divide. Women who do gain access to digital devices and connectivity often curtail their use in response to online harassment, surveillance by family members, or fear of reputational harm, particularly in contexts with restrictive social norms around women's public visibility (Singh et al., 2025). Because online safety is treated as a core competence within the Digital Literacy Global Framework rather than a separate issue (Law et al., 2018), literacy curricula that omit explicit safety and digital-citizenship content are likely to under-serve women learners, even when technical training is otherwise sound.

2.4 Digital Literacy, Empowerment, and Sustainable Development Outcomes

A parallel literature examines the pathways through which digital literacy translates into empowerment outcomes relevant to sustainable development. These pathways cluster around four domains. First, economic empowerment: digital literacy enables women to access online marketplaces, financial services, and remote or flexible work arrangements that can circumvent some of the mobility and workplace-based constraints they otherwise face (OECD, 2018; World Bank, 2024). Second, educational access: digital platforms extend access to learning materials and credentialing opportunities beyond the reach of physical infrastructure, which is particularly consequential in rural or under-resourced settings (Law et al., 2018). Third, access to information and services: digital literacy allows women to obtain health information, government entitlements, and market prices directly rather than through intermediaries, a pathway with demonstrated relevance in agricultural and rural-development contexts (Tata Trusts, n.d.). Fourth, civic and political voice: digital platforms provide channels for advocacy and collective organising that can supplement or substitute for exclusion from offline public spaces (Wajcman, 2004). Each of these pathways is conditional rather than automatic; the same literature that documents these benefits also cautions that they materialise only when digital-literacy programs pair affordability, content relevance to women's daily concerns, and protection from online harm (Singh et al., 2025).

2.5 Documented Digital-Literacy Interventions

Several large-scale, publicly documented interventions show how these principles have been operationalised and provide the empirical basis for the thematic synthesis in Section 4. In India, the government's Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA), approved in 2017 under the wider Digital India program, targeted six crore (60 million) rural households for basic digital literacy training, with explicit provisions prioritizing women, Scheduled Castes, Scheduled Tribes, and below-poverty-line households; by 2024 the scheme had enrolled 7.35 crore candidates and certified 4.78 crore of them, delivering a standardized twenty-hour curriculum in twenty-two scheduled languages (Ministry of Electronics and Information Technology [MeitY], 2024). A complementary private-sector initiative, Internet Saathi — a joint program of Tata Trusts and Google launched in 2015 — trained rural women as community-based digital trainers ("saathis") using a train-the-trainer model; by the program's own published figures, it had built a network of close to 60,000 saathis who had introduced more than 20 million women across some 200,000 villages to basic internet use (Tata Trusts, n.d.). These two programs differ in instructive ways: PMGDISHA relied on a standardised, government-delivered curriculum with certification, whereas Internet Saathi relied on peer-to-peer delivery through locally trusted women trainers — a design choice consistent with the literature's emphasis on social trust and cultural proximity as determinants of women's program uptake (Antonio & Tuffley, 2014; Singh et al., 2025).

3. Methodology

Because no new primary data (surveys, interviews, or experimental data) were collected for this study, the research is conducted as a critical, thematic literature review rather than as a primary empirical study. This approach fits the research questions, which focus on synthesising and evaluating dispersed existing evidence rather than generating new observations. The review followed a structured, though not full-PRISMA-protocol, search and synthesis process.

Search strategy. Sources were identified through targeted searches of institutional repositories and databases (the ITU's Measuring Digital Development series, GSMA's Mobile Gender Gap Report series, World Bank and OECD publication portals, UNESCO Institute for Statistics publications, and the Government of India's Press Information Bureau) alongside peer-reviewed academic literature indexed in sources such as MDPI's Future Internet, Emerald's Digital Transformation and Society, and Elsevier's Women's Studies International Forum. Search terms combined "digital literacy," "digital divide," "gender," "women's empowerment," and "sustainable development," with supplementary searches for named programs once they were identified in the literature (e.g., "Internet Saathi," "PMGDISHA").

Inclusion criteria. Sources were included if they (a) reported empirical data on gender differentials in digital access, skills, or outcomes; (b) presented a peer-reviewed theoretical or conceptual account of the digital divide or digital literacy; or (c) documented, with verifiable primary or institutional sourcing, a digital-literacy program with a stated gender focus. Sources were excluded if their factual claims could not be corroborated against an identifiable primary or institutional source, consistent with the review's aim of building only on verifiable evidence.

Synthesis approach. Retained sources were read and organised thematically rather than program-by-program, using an inductive coding process in which recurring concepts (access barriers, skills barriers, safety barriers, empowerment pathways, and program design features) were identified across sources and then used to structure the discussion in Section 4. This thematic-synthesis approach is standard in critical and narrative literature reviews and allows convergent and divergent findings across quantitative institutional datasets and qualitative program documentation to be considered together.

Limitations of the method. A thematic literature review cannot establish causal relationships with the precision of a controlled study, cannot generate new context-specific data (for example, from a specific district or state not already covered by the cited sources), and is necessarily bounded by what has been documented and made publicly available by the institutions and researchers cited. Section 6 addresses these limitations further.

4. Thematic Discussion

4.1 Access Is Necessary but Not Sufficient

The evidence reviewed in Section 2 supports a central claim of this paper: policies that treat connectivity as the primary bottleneck will systematically under-deliver on gender-equality outcomes. Global data show gender

parity in internet use has been achieved in some regions — the Americas, Europe, and the Commonwealth of Independent States — while it remains furthest away in the Arab States, where the gender parity score has not improved in recent years, and in Africa, where progress continues but from a low base (ITU, 2024). Where access has improved without a parallel skills investment, usage patterns among newly connected women often remain narrower than those of men — for example, weighted toward messaging and social use rather than the financial, informational, and economic uses associated with the largest livelihood gains (OECD, 2018; World Bank, 2024). This pattern is consistent with Van Dijk's (2005, 2006) argument that skills access and usage access are analytically and empirically distinct from physical access, and it implies that digital-literacy programming should be treated as a complement to, not a byproduct of, connectivity investment.

4.2 Digital Literacy as a Multiplier for Existing Empowerment Pathways

Rather than functioning as an independent driver of empowerment, digital literacy appears in the reviewed literature primarily as a multiplier that strengthens pathways already recognised in the gender-and-development literature: education, income generation, health information, and civic voice. The Internet Saathi program illustrates this multiplier effect concretely: trained women reportedly used their new skills not only for personal internet use but to access government schemes, search for information relevant to their households, and, through the affiliated Foundation for Rural Entrepreneurship Development, to pursue economic opportunities (Tata Trusts, n.d.). This aligns with Hilbert's (2011) finding that women's lower digital participation is largely explained by pre-existing disadvantages in income, education, and employment, since it implies that digital-literacy training delivered without complementary economic or educational support is unlikely, on its own, to close the empowerment gap it targets. Programs that pair digital-skills training with livelihood or entrepreneurship components — as Internet Saathi did through FREND — appear better aligned with the evidence on what actually constrains women's technology use than programs that treat digital-skills acquisition as a self-contained end.

4.3 Program Design Features That Correlate With Reach

Comparing the design of PMGDISHA and Internet Saathi against the barriers identified in Section 2 highlights several design features associated with documented reach among women. First, delivery through trusted, socially proximate intermediaries — as in the "saathi" peer-trainer model — appears to lower the social and cultural barriers to women's participation identified by Antonio and Tuffley (2014), since training is delivered by other women within the same community rather than through unfamiliar external institutions. Second, standardised government curricula such as PMGDISHA's twenty-hour, multi-language modules provide the scale and consistency needed to reach tens of millions of learners and to generate the certification and monitoring data that inform SDG Indicator 4.4.2 reporting, but by design cannot offer the same degree of contextual tailoring as a community-embedded model (Law et al., 2018; MeitY, 2024). Third, explicit targeting provisions — PMGDISHA's prioritisation of women alongside Scheduled Castes, Scheduled Tribes, and below-poverty-line households — reflect an intersectional design logic broadly consistent with the OECD's (2018) and World Bank's (2024) emphasis on addressing compounding disadvantages rather than gender in isolation. None of the documented programs reviewed here, however, publish sex-disaggregated outcome data beyond enrollment or training counts (for example, post-training income or continued-use rates by gender), which limits the extent to which their comparative effectiveness for women specifically can be assessed from public information alone — a gap discussed further in Section 4.4.

4.4 Persistent Gaps: Safety, Monitoring, and the Missing Data Layer

Despite the scale achieved by programs such as PMGDISHA and Internet Saathi, the literature reviewed here points to at least three unresolved gaps. First, online safety and gender-based digital violence remain comparatively under-addressed in program documentation, even though safety is defined as a core digital-literacy competency (Law et al., 2018) and is highlighted in the broader literature as a significant deterrent to sustained use among women (Singh et al., 2025). Second, sex-disaggregated monitoring and evaluation data are inconsistently published; global institutional reports (ITU, GSMA, World Bank) provide robust sex-disaggregated data at the national and regional level, but individual program evaluations more often report aggregate reach figures, making it difficult to assess differential gender impacts within a given intervention. This is consistent with a broader "gender data gap" noted across the sustainable-development literature. Third, and relatedly, most publicly available program documentation emphasises reach (numbers trained) over outcome (subsequent economic, educational, or civic use), which constrains the evidence base available to this and future reviews and

reinforces the case, developed in Section 6, for further primary research using longitudinal and sex-disaggregated designs.

5. Policy Recommendations

Drawing on the synthesis above, five policy directions follow directly from the identified gaps rather than from generic best-practice lists.

5.1 Treat affordability and access as a floor, not a solution. Because gender parity in usage has not followed gender parity in access in several regions (ITU, 2024; OECD, 2018), device- and connectivity-subsidy programs should be paired from inception with funded digital-literacy components, rather than treated as a preceding phase to be followed by skills training later.

5.2 Prioritise socially proximate, peer-based delivery models where cultural or mobility barriers are significant. The comparative advantage of the Internet Saathi model in reaching rural women (Tata Trusts, n.d.) suggests scaling community-trainer approaches alongside, not instead of, standardised government curricula such as PMGDISHA, with each model serving the reach and depth objectives it is best suited to.

5.3 Embed online-safety and digital-citizenship modules as mandatory, not optional, curriculum components. Given that safety concerns are a documented driver of women's reduced or discontinued digital use (Singh et al., 2025) and are already defined as a core competence in the UNESCO Digital Literacy Global Framework (Law et al., 2018), safety training should be assessed and certified with the same rigour as technical skills, rather than delivered as supplementary awareness content.

5.4 Mandate sex-disaggregated outcome monitoring, not only enrollment monitoring. Programs should be required to publish post-training outcome indicators (continued use, income change, service access) disaggregated by sex, consistent with the "gender data gap" concerns raised across the sustainable-development literature, so policymakers can distinguish programs that close usage and outcome gaps from those that only close enrollment gaps.

5.5 Bundle digital-literacy training with economic and educational complements. Because much of the residual gender gap in technology use reflects underlying disadvantages in income, education, and employment rather than technology aversion per se (Hilbert, 2011), digital-literacy programs are likely to be more effective when integrated with, rather than delivered separately from, livelihood, entrepreneurship, or continuing-education programming, following the model piloted through FRENED alongside Internet Saathi.

6. Conclusion

This paper examined, through a critical review of verifiable secondary evidence, how digital literacy relates to gender equality within the framework of sustainable development. The review indicates that the gender digital divide, while narrowing, remains substantial and is driven less by an intrinsic aversion to technology among women than by compounding socio-economic disadvantages in income, education, employment, and safety (Antonio & Tuffley, 2014; Hilbert, 2011). Digital literacy functions best as a multiplier of existing empowerment pathways rather than a stand-alone solution, and the documented programs examined here—PMGDISHA and Internet Saathi—illustrate complementary design approaches, government-standardised and community peer-based, respectively, that together address different dimensions of the same underlying problem. At the same time, the review identified a persistent evidence gap: publicly available program documentation emphasises reach over outcome and rarely disaggregates results by sex beyond enrollment, limiting confident causal claims about differential program impact.

6.1 Limitations

As a literature-based critical review rather than a primary empirical study, this paper is bounded by the scope and quality of publicly available secondary sources. It cannot offer new quantitative estimates of digital-literacy gaps specific to any one region not already covered by the cited institutional data, cannot establish causal impact estimates that only controlled or longitudinal primary studies can provide, and is limited to programs and datasets that have been made publicly available in verifiable form; unpublished or non-public program data could not be incorporated.

6.2 Directions for Future Research

Building directly on the gaps identified in Section 4.4, three lines of primary research would substantially strengthen the evidence base. First, longitudinal, sex-disaggregated evaluation of specific digital-literacy programs — tracking participants' post-training economic, educational, and civic outcomes over multiple years — would allow the reach-versus-outcome distinction identified in this review to be resolved empirically. Second, intersectional research examining how gender interacts with caste, class, rurality, disability, and age in shaping digital-literacy outcomes would extend the largely gender-only framing of the current institutional datasets. Third, primary survey- or interview-based research conducted directly with women learners and trainers within specific programs (for example, PMGDISHA or Internet Saathi beneficiaries in a defined region) would allow researchers to test, rather than infer, the mechanisms proposed in Section 4 — such as the role of peer trust in program uptake — using data this review, by design, does not itself collect..

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