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Educational Equity in the Algorithmic Era: Gender Equality Challenges and Strategic Responses in Digital Intelligence-Driven Educational Transformation

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Abstract: This study demonstrates that the deployment of digital intelligence technologies in education has not only fallen short of delivering equitable outcomes but has systematically intensified gender disparities through three fundamental mechanisms: institutionalized algorithmic bias, symbolic monopoly, and the erasure of labor. Within the context of declining birthrates and population aging, technological alienation has further constrained female development—reducing mothers to "education workers" saddled with "digital domestic management" while marginalizing elderly women in digital learning spaces. The research contends that education systems must embrace their "remediation" imperative by deliberately aligning technological frameworks with gender justice principles. Empirical studies confirm that algorithmic auditing can demystify technological black boxes, STEM quota policies can challenge symbolic monopolies, and digital labor quantification can expose hidden exploitation. These reforms carry strategic importance in the context of demographic transitions: reducing maternal burdens to support fertility rates, advancing age-friendly technology democratization to address population aging, and safeguarding algorithmic equity to prevent female exclusion from AI-dominated future workplaces—collectively fostering a lifelong learning environment that supports family formation, embraces all ages, and ensures technological justice.

Keywords: Educational technology; Gender equality; Algorithmic bias; Symbolic monopoly

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1. Introdution: The Intersection of Technology, Education, and Gender Equality

During the third decade of the 21st century, human society is experiencing transformative shifts: fundamental global demographic restructuring and the AI- and big data-driven digital revolution stand out as defining phenomena, while the evolving gender equality discourse continues to generate sustained scholarly and public engagement. As the world marks the 30th anniversary of the UN Fourth World Conference on Women, significant progress has been achieved globally in promoting women's advancement and gender equality. Yet the intensifying low-fertility trap and rapidly aging populations are fundamentally reshaping gender roles in social reproduction and caregiving responsibilities. Access to education remains a pivotal strategy for empowering women, facilitating their personal and career development, narrowing gender disparities, and driving inclusive growth[1]. In this context, education must urgently serve as an enabler for women to transcend traditional role limitations and pursue lifelong development.

Concurrently, digital and intelligent technologies continue to make groundbreaking innovations, with smart

environments now deeply transforming educational paradigms, cultural norms, and ecosystems [2].Online learning platforms, adaptive assessment systems, and algorithm-driven resource allocation mechanisms are heralded as catalysts for educational equity, personalized learning, and enhanced efficiency. Policy narratives often reductively frame technology as a neutral instrument, attributing to it an inherent capacity for universal benefit. Yet feminist Science and Technology Studies (STS) demonstrates how technological design, deployment, and implementation are deeply embedded within existing power structures, potentially reproducing, intensifying, or even creating systemic inequalities[3]. While education should fundamentally advance social justice and equity, it is increasingly governed by algorithmic rationality and data-driven paradigms. This presents a crucial paradox: does technology mitigate or exacerbate gender disparities in education?

The current mainstream discourse on gender dimensions in educational technology reveals notable blind spots that demand more rigorous critical examination.

Firstly, Research perspectives disproportionately concentrate on the "First-Level Digital Divide",[1] while largely overlooking more profound gender disparities in skill acquisition, practical application, and benefit realization[4,5]; Secondly, current studies exhibit a systemic deficiency in critiquing implicit gender biases permeating the entire educational continuum—from admissions and pedagogical practices to administrative decisions and academic assessments—as well as their ultimate educational outcomes and societal repercussions[6]. Particularly concerning is the research gap that persists despite technology's deepening integration into education ecosystems, with alarmingly limited empirical evidence addressing implicit biases in online learning environments[7].

Thirdly, the author contends that women navigating demographic transitions are increasingly subjected to compounded identities—as mothers, professionals, and eldercare providers—yet prevailing technological frameworks neglect to accommodate the learning demands inherent to these multifaceted roles. Without gender-responsive design, educational technology risks erecting new obstacles to attaining Sustainable Development Goals 4 (Quality Education) and 5 (Gender Equality) globally. This study situates itself at the confluence of these three dimensions to examine two pivotal questions: In an era marked by profound demographic transformations and exponential technological progress, how do digital intelligence technologies perpetuate or intensify gender disparities in education through mechanisms including algorithmic bias, digital violence, and cultural reproduction? How might educational systems leverage institutional redesign, curricular reform, and teacher capacity-building to harness technology as an instrument for advancing gender equity?

Drawing upon critical pedagogy and feminist science and technology studies, this research will analyze the operational logics of these technologies and develop a proactive intervention framework for education. These inquiries carry substantial significance for realizing educational justice, unlocking women's human capital potential, and responding to low fertility rate challenges.

2. Theoretical Perspectives: Deconstructing Gender Power Structures in Educational Technology Ecosystems

The integration of digital-intelligent technologies in education transcends mere tool adoption, representing a technological mediation that reshapes existing social power dynamics. This section synthesizes three theoretical frameworks—Feminist Science and Technology Studies (Feminist STS), Critical Pedagogy, and Critical Algorithm Studies—to establish an analytical model for examining the reproduction mechanisms of gender inequality in digital education.

2.1. Feminist Technology Studies: Exposing the Gendered Dimensions of Technology

Feminist technology studies challenge conventional assumptions of technological neutrality. This theoretical approach demonstrates that technological artifacts are not value-free instruments, but rather material embodiments of social relations whose design paradigms are fundamentally rooted in patriarchal structures[8].Taking educational algorithms as an example, the selection of training data often relies on historically gendered records, such as male students' disproportionate

participation in STEM course interactions, causing algorithms to inadvertently codify social biases as "objective truths"[9]. This "technological unconsciousness" automates and institutionalizes gender discrimination in intelligent education systems[10], ultimately creating a new paradigm of domination called "Technopatriarchy".

Furthermore, educational technology applications remain subject to gendered constraints. While digital learning platforms offer women spatiotemporal flexibility to some degree, they fail to address potential adverse consequences. The "anytime, anywhere" learning model may exacerbate women's workload during "The Third Shift"[11], as it implicitly relegates learning tasks to the domain of fragmented time management. For women bearing heavy caregiving responsibilities, this means they can only snatch fragmented learning opportunities between household chores. Such persistent time fragmentation and constant task-switching insidiously compound their mental exhaustion and burdens, ultimately failing to achieve genuine female emancipation. The simplistic glorification of technological empowerment risks obscuring its collusion with entrenched gender-based labor divisions.

2.2. Critical Pedagogy: Education as a Political Battleground of Inequality

Critical pedagogy contends that education serves not as a neutral space but as an ideological arena where hidden curricula perpetuate social disparities[12]. Within digital-educational ecosystems, this reproduction gains technological reinforcement: certain adaptive learning algorithms leverage biased historical data to channel female students toward humanities while diluting mathematics rigor—ostensibly protective measures that ultimately constrain developmental prospects and reinforce gendered trajectories[13]; behavioral quantification technologies privilege masculine learning paradigms emphasizing hyper-focus and competitiveness, systematically marginalizing collaborative approaches; AI-assisted teaching tools perpetuate gendered assessments, with algorithmic labels like "meticulous" cementing restrictive role expectations. As Michel Foucault (1979) elucidates in "Discipline and Punish", modern societies exercise control through three micro-technologies—hierarchical surveillance, normative judgment, and examination—effecting discipline via perpetual, invisible corporeal conditioning and psychological internalization[14].Today, algorithmic labeling and bias represent nothing short of an evolution in disciplinary techniques. Under the veneer of "smart" technological gimmicks, such control mechanisms become even more insidious and readily accepted. Education must demystify the power dynamics concealed within technological myths. When educators adopt AI tools without critical reflection, they inadvertently bypass essential scrutiny of epistemic authority and systemic boundaries, thereby perpetuating gender inequities.

2.3. Algorithmic Critique Theory: Systemic Exclusion in Educational Decision-Making

The implementation of algorithms in education fundamentally restructures opportunity distribution mechanisms. Virginia Eubanks' (2018) conceptual framework of "Automating Inequality" offers particularly salient insights: "Predictive algorithms institutionalize historical biases, systematically categorizing marginalized populations as 'high-risk' or 'low-potential' through digital profiling[15]."Algorithmic exclusion in educational contexts exhibits multifaceted gender disparities: input bias occurs when admission systems trained on male-dominated "successful alumni" datasets collectively categorize female leadership qualities as deficient in "leadership potential"[16]; opaque decision-making manifests in student loan algorithms that assess default risks through zip codes and family structures, systematically disadvantaging single-mother families. These converging crises demonstrate how educational access and entitlements are increasingly governed by impenetrable, non-negotiable algorithmic mechanisms, potentially dulling women's recognition of such systemic biases or compelling passive acceptance of automated decisions—resulting in eroded agency and diminished capacity for resistance.

Furthermore, research reveals adolescent girls experience disproportionate cyberviolence, with digitally amplified harmful content infiltrating school environments, as evidenced by victimized female students in Brazil and Spain[17]. The pervasive harms and privacy violations inflicted by social media algorithms on women within educational spheres warrant immediate intervention and systemic reform. Scholars have developed and validated an educational technology tool called "Alertmeter" to improve women's awareness and ability to identify violent behaviors[18].

These theories do not exist in isolation but collectively reveal gender inequality and its perpetuation within the educational technology ecosystem. This phenomenon stems from the intersection of three key elements: the gender-biased design of technological artifacts, the entrenched power structures and ideologies in educational settings, and the inherent biases in algorithmic systems (**Figure 1**). Under this framework, educational technology systems risk elevating the experiences of specific demographics to universal truth standards. To overcome this challenge, all stakeholders in education must adopt a critical approach when engaging with technological and digital tools.

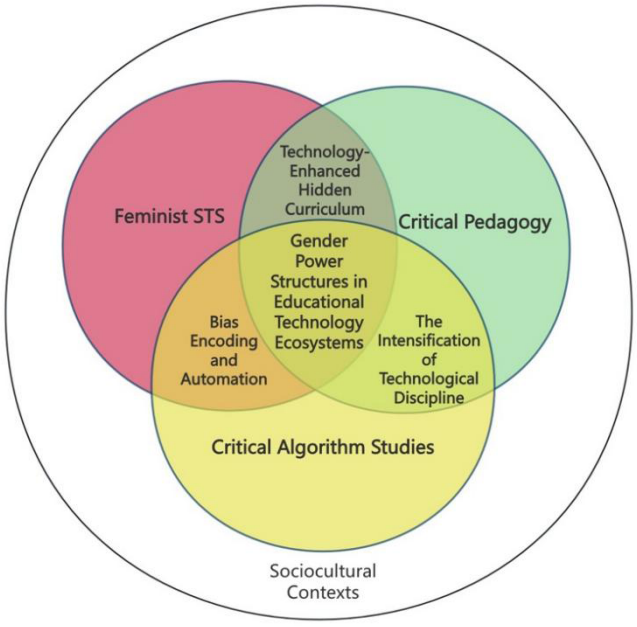

Figure 1. Theoretical Frameworks for Gender Power Structures in Educational Technology Ecosystems

3. Opportunity and Empowerment: How Digital Intelligence Technology Unlocks New Possibilities for Gender Equality in Education

The enabling potential of digital and intelligent technologies for gender equality in education cannot be realized automatically, as technology itself is no "silver bullet." Access, application, and effectiveness are not inherent in the technology but contingent upon multiple factors: users' digital competencies, available time and space for technology use, financial capacity to acquire smart devices, potential design biases in the technology itself, and societal encouragement for specific groups to adopt these tools. In practice, these prerequisites frequently manifest as systemic barriers for female users.

Furthermore, the tangible benefits remain circumscribed by entrenched social structures. Constrained by traditional gender divisions of labor, women often lack adequate bandwidth for online learning, while those in underprivileged regions face compounded disadvantages in device accessibility and digital skills development opportunities. However, the restructuring of educational ecosystems through digital and intelligent technologies also creates avenues to overcome traditional gender barriers. This section explores technology's transformative potential through an optimistic yet critical lens.

3.1. Eliminating Spatiotemporal Constraints and Broadening Lifelong Learning Opportunities

The widespread adoption of online education platforms and mobile learning technologies has substantially alleviated geographical barriers and time fragmentation affecting women's education. For rural women whose career choices are heavily constrained by domestic responsibilities, the internet expands access to employment information and increases

autonomy in non-farming occupations[19]. While not directly educational, this indirectly promotes their intellectual development. Those juggling agricultural work and unpaid caregiving can now utilize fragmented time to broaden perspectives while reducing information-gathering and skill-acquisition costs, effectively transcending spatial limitations through virtual means. Urban working mothers, meanwhile, can leverage asynchronous online courses to mitigate knowledge gaps resulting from career breaks during motherhood. Notably, amid rapid population aging, senior-friendly digital interfaces—featuring voice interaction, animated tutorials, and simplified operations—combined with optimized training approaches like bite-sized lessons, frequent practice sessions, and instructional manuals, help address elderly women's misconceptions about social development. These solutions empower them to enhance later-life independence through courses on health literacy, financial management, and personal interests, thereby escaping the "capability deprivation trap" [20, 21].However, such empowerment hinges on the premise of "discretionary time", inadvertently masking the dual burdens and gendered stereotypes imposed on many mothers. Public discourse routinely frames "childcare responsibilities" as inherently maternal, while "intensive mothering" ideology demands mothers prioritize their children through exhaustive emotional, temporal, and financial investments—a standard exacerbated by digital technologies, culminating in tech-facilitated maternal guilt[22]. The perpetual connectivity of educational tools erodes boundaries between women's personal and familial spheres, heightening role strain. Should a mother pursue online courses for self-improvement or parenting knowledge, only to be condemned for offering "physically present yet psychologically distant" care, she faces renewed societal double binds.

3.2. The Openness Revolution of Resources and the Potential for Hidden Curriculum Reconstruction

The exponential growth of digital resource libraries theoretically offers new avenues for dismantling gender segregation in academic disciplines. Virtual labs and MOOC platforms can provide gender-neutral immersive learning experiences. Emerging courses led by female scientists and researchers, coupled with online knowledge-sharing by women professionals, vividly demonstrate "her power" to the public. A notable example is the 2023 "Outstanding Women Netizens: Female Open Courses" initiative, co-organized by the All-China Women's Federation's Women's Voice, China Women's News, and Zhihu, which featured female scientists livestreaming their research journeys, career insights, and field breakthroughs across platforms like WeChat Video Channels, Weibo, and Douyin.

The Samsung STEM GIRLS program targets girls aged 12-16, aiming to cultivate their scientific interests through STEM education and hands-on technological activities. Designed to foster global perspectives, innovation skills, and social responsibility, the program encourages participants to pursue research careers. Under the guidance of female experts from Tsinghua University and the Chinese Academy of Sciences, it incorporates role models and offers a free online learning platform, reaching over 70,000 participants.

Additionally, the Inter-American Network of Academies of Sciences (IANAS) conducts its "Women in Science" lecture series, accessible via Zoom and YouTube livestreams. A growing number of cases are challenging the male-dominated cultural paradigm in STEM fields. Meanwhile, the increasing visibility of women in open-source programming communities is reshaping gender perceptions in technical careers. More fundamentally, educational big data visualization technologies are exposing structural inequalities—including disparities in inter-school resource allocation and gender participation rates across disciplines—thereby offering clear policy intervention points. Yet resource accessibility doesn't necessarily translate to influence: when algorithmic recommendation systems consistently deliver "gender-conforming" content, technology ironically reinforces cultural stereotypes[23].

3.3. The Paradoxical Promise of Skill Democratization

The low-code development platform[3] of AI-aided design platforms theoretically serve as a springboard for marginalized women to access high-growth digital sectors. Rural women's e-commerce livestreaming initiatives reveal that acquiring short-video skills can rapidly convert into economic gains, transforming household financial dynamics and creating expanded opportunities for women[24].

Yet this "rapid upskilling" narrative harbors hidden traps: First, it channels women into low-value digital labor while masking how algorithmic control remains concentrated among tech elites[25]. Second, despite persistent challenges like language barriers, traditional mindsets, and infrastructure gaps in impoverished regions, framing structural inequalities as mere "individual skill gaps" deflects attention from education systems' failure to nurture critical technological literacy[26]. Technology is often envisioned as a panacea for educational challenges, mistakenly perceived as a purely neutral instrument while disregarding its underlying political-economic foundations and societal power structures. Without systemic interventions to address root issues like inequitable digital resource allocation, algorithmic biases, and the devaluation of care work, technology's purported opportunities will only perpetuate existing disparities. The education system's critical mission lies in actively constructing institutionalized gender equity frameworks to harness technology's potential as a genuine equalizing force, rather than passively awaiting market-driven adjustments.

4. Risks and Challenges: Implicit Gender Exclusion in Educational Technology Ecosystems

4.1. The Scientism Facade of Algorithmic Decision-Making and Institutionalized Bias

Growing dependence on intelligent systems in education—from admissions prediction models to classroom behavior analytics—risks perpetuating gender discrimination under the pretense of "objectivity". Amazon's recruitment algorithm notably penalized resumes featuring terms like "women's", "robotics", or "club" for technical roles, reflecting historical male dominance in such positions[27]. These algorithmic biases, when transposed to education, demonstrate how STEM field data distortions systematically skew outcomes. Educational assessment criteria often mirror ruling-class cultural capital, framing feminine emotional expression as "deficient linguistic practice" to reinforce gender hierarchies. The mandated "de-emotionalization" in essay evaluation fundamentally represents patriarchal suppression of care ethics [28,29]. Such ideological underpinnings risk being hardwired into developing educational technologies, including automated grading systems and learning assessment platforms. Algorithmic bias institutionalizes inequitable data foundations and technological opacity. At the core of algorithmic decision-making lies its dependence on historical data. Educational "success" metrics are inherently shaped by persistent gender stereotypes and structural inequalities. When algorithms process these historically and systemically biased datasets, they not only perpetuate existing discrimination but also codify these biases into ostensibly "objective" predictive models. The inherent complexity of algorithms coupled with corporate secrecy protections creates profound opacity in decision-making processes. By framing discriminatory outcomes derived from biased data as "scientifically validated algorithmic decisions", the system effectively masks injustice under the veneer of technological authority. Educational administrators, and even the affected individuals themselves, may feel compelled to accept algorithmic outcomes due to their limited ability to comprehend or challenge the underlying logic. This leads to the institutionalization of bias—embedding discriminatory patterns into core educational processes like admissions, class assignments, resource distribution, and performance evaluations, ultimately establishing a deeply rooted "new normal". Such institutionalization significantly weakens conventional gender equity oversight mechanisms.

The impact of algorithmic bias on elderly women proves particularly insidious. Training datasets often carry implicit assumptions equating advanced age with diminished learning capacity, causing age-adaptive learning platforms to systematically offer older women content with reduced complexity and intellectual challenge. Moreover, these systems frequently restrict their recommended content to traditional domains like wellness and domestic matters, while neglecting their potential aspirations for career advancement, social engagement, or emerging technology education. This fundamentally denies them equitable access to digital lifelong learning opportunities.

4.2. The Masculine Construction of Technical Authority and Its Exclusionary Effects

The symbolic monopoly reinforces both the masculine identity of technical authority and the hidden curriculum. Educational technology's material sign system—encompassing interface design, course examples, virtual avatars, and

instructional themes—perpetuates the implicit equation of "technology with male dominance". Programming software's default war/gaming motifs, the exclusive portrayal of male engineers in robotics textbooks, and the underrepresentation of female scientists in STEM curricula collectively erode girls' sense of affiliation and belonging in technical domains[30]. This symbolic domination extends beyond representation, infiltrating daily pedagogical practices where teachers disproportionately assign boys to operate smart devices while delegating girls to auxiliary roles like note-taking or support tasks. This embodied practice perpetuates the gendered division of labor in technological power structures, conditioning girls to internalize the role of "observers" rather than "controllers" from their initial exposure to technology. Moreover, women in tech encounter a "glass ceiling" when advancing to leadership roles, with the underlying consequence of symbolic monopoly manifesting as their continued exclusion from technology development and decision-making spheres—evidenced by women constituting merely 4.3% of core developers in open-source projects[31]. Consequently, educational technology design inherently lacks gender considerations, systematically neglecting critical issues like elderly women's cognitive patterns, pregnant educators' usability requirements, and mothers' fragmented schedules. Technological products predominantly cater to the "unencumbered young male" as default users, relegating other demographics' experiences to exceptional cases requiring post-design "accommodation" rather than serving as foundational design parameters.

4.3. The Invisibilization of Labor: Shifting Educational Responsibilities and Exacerbating Gendered Class Divisions

The proliferation of parent-teacher communication apps, online homework platforms, and health reporting systems has offloaded substantial educational management and coordination duties—including homework supervision, information verification, activity enrollment, and health tracking—from schools and society onto households, with mothers disproportionately shouldering the burden. Compelled to master intricate app functionalities late at night, juggle multiple parent chat groups, and guarantee on-time completion of numerous "digital assignments", mothers have been transformed into unpaid "digital education laborers". While this invisible work underpins the digital infrastructure of education, it remains dismissed as "maternal instinct" and systematically excluded from formal recognition within societal labor valuation frameworks. The requirements of digital care work inadvertently heighten barriers for women—especially socioeconomically disadvantaged mothers with limited digital literacy—to effectively engage in online learning or access educational technology resources. Their already scarce time and energy are further depleted by digital tasks, leaving minimal capacity for self-improvement through learning. Consequently, while educational technology appears to broaden access, it actually widens gender and class disparities in educational opportunities—privileging women with resources (time, skills, support networks) while further marginalizing those overburdened with care responsibilities.

Older women frequently occupy a more nuanced position in digital care work dynamics. While they themselves may face exclusion from learning due to the digital divide, in China's intergenerational care culture they often become enmeshed in "cross-generational digital labor"—helping grandchildren with online learning through device operation or task supervision—an equally invisible and unrecognized form of labor.4.3 Dynamic Coupling of the Triple Mechanism:

Algorithmic bias lends "scientific" legitimacy to symbolic monopoly: algorithm-generated conclusions like "female students exhibit lower mathematical aptitude" or "single mothers represent higher credit risks" provide seemingly objective "data validation" for entrenched gender stereotypes (symbolic monopoly) in education. This veneer of scientific credibility renders such biases more insidious and convincing, perpetuating male authority in tech domains.

Symbolic monopoly molds both algorithm designers and datasets: The male-dominated tech landscape (a manifestation of symbolic monopoly) fosters homogeneous development teams. Their unconscious prejudices and experience-centric design paradigms inevitably infiltrate algorithmic modeling and data curation, systematically generating or exacerbating algorithmic bias at its origin. The invisibility of labor obscures and perpetuates the first two mechanisms: mothers and older women become ensnared in demanding yet invisible digital care labor, draining the time, energy, and agency required to confront algorithmic inequities (such as contesting biased outcomes) or dismantle the symbolic

dominance of technological authority (such as mastering programming skills). This enables algorithmic prejudices and symbolic monopolies to thrive and escalate in an environment devoid of meaningful opposition.

These three interlocking mechanisms reinforce one another under the guise of data and algorithms' "objectivity". Through technological tools (surveillance, rating systems, recommendations, task delegation), they mechanistically impose patriarchal disciplinary frameworks (gendered role divisions, presumed competencies, power hierarchies) while deftly offloading educational responsibilities onto women's unpaid labor. Consequently, they systematically reproduce and intensify gender disparities within the educational landscape. Therefore, addressing gender inequality in educational technology must extend beyond superficial assessments of access gaps or skill differentials. A critical examination is needed to reveal how three entrenched mechanisms—institutionalized algorithmic bias, symbolic domination, and the systemic erasure of labor—interlock and mutually reinforce one another, perpetuating a gendered exclusion framework.

This structural marginalization hits hardest among mothers and older women, who bear disproportionate burdens amid declining fertility rates and population aging. Effective countermeasures must adopt an integrated approach that simultaneously targets these interwoven mechanisms.

5. Educational Response: Constructing a Gender-Sensitive Governance Framework for Digital Education

5.1. Implementing Algorithmic Accountability and Democratized Technology Mechanisms

Inspired by Article 29 of the EU's AI Act, the Ministry of Education should mandate algorithmic impact assessments for education, compelling all public institutions and contracted third-party platforms to disclose core algorithm logic—including decision trees for admissions filtering and course recommendations—while submitting regular performance audit reports. Establish an educational data ethics committee with gender studies experts and frontline female educators participating in technology procurement reviews, restricting purchases of AI tutoring systems that perpetuate stereotypes. Create dedicated algorithmic appeal channels enabling both educators and students to contest gender-discriminatory recommendation results. The key to establishing a tiered and accountability-defined gender-sensitive governance framework lies in addressing the disconnect between policy formulation and execution. At the national level, institutional robustness must be enhanced: the Ministry of Education should coordinate with internet regulatory bodies to promulgate relevant policies or guidelines, delineating high-risk areas such as admissions and financial aid. Provincial-level platforms should be required to disclose their decision-tree algorithms, with third-party entities like university-based computational social science centers conducting annual gender parity audits focusing on measurable indicators like resource allocation accuracy and grievance rates. Concurrently, textbook approval criteria should be amended to institute minimum representation thresholds for female scientists in STEM case studies, thereby dismantling symbolic gender disparities at their root.

Provincial education authorities must function as implementation hubs: consolidating fragmented school-family applications within their jurisdictions while capping mandatory monthly tasks at three items maximum. They should also institute algorithmic grievance mechanisms, ensuring human review and response within 72 hours by school-based data ethics committees (comprising gender studies faculty and student representatives).Municipalities are rolling out a lightweight intervention toolkit: "15-minute digital literacy hubs" in community schools offer volunteer-led crash courses on education platform navigation, while family-friendly cities pilot "maternal education time credits" programs that convert technology training hours into after-school care services.

Schools and corporations must implement granular measures: banning teachers from using gender-biased AI feedback, adding hands-on modules about decoding gendered app interfaces in IT curricula, and subjecting edtech whitelist candidates to dynamic evaluations with senior/maternal-friendly design as key metrics. This multilayered framework operates through triple mechanisms—quantifiable algorithm audits, textbook oversight authority, and community-driven service innovations—guaranteeing policy instruments remain measurable, trackable, and answerable.

5.2. Breaking the Gender-Symbol Monopoly in Technical Authority

Introduce a critical digital literacy module into primary and secondary school IT curricula to help students analyze gender coding in game character design and facilitate cross-gender virtual experiences through gamified learning. Teachers should maintain linguistic precision in instruction, refraining from suggestive statements like "boys have better logical skills" and actively minimizing gender stereotypes in educational practices. Incorporate gender equality content into digital courses, ensuring teaching materials and case studies showcase diversity—including contributions from scientists across genders—while avoiding occupational stereotyping. Technical instruction and activities should employ inclusive design principles to ensure equitable participation for all students. A key procedural strategy involves deferring the collection of students' demographic data, such as gender, until later stages of courses or assessments. When students are not required to recognize at the start of a task that they might be associated with a group susceptible to negative stereotypes, they can better concentrate on the learning material itself, alleviate anxiety, and consequently showcase their genuine capabilities and potential more effectively. Nationally, efforts should prioritize increasing the visibility of female scientists in STEM case studies within educational resource platforms, establishing quotas for women in edtech R&D, and mandating minimum female participation thresholds in provincial-level educational IT project teams—particularly ensuring female technical leadership in areas like senior education and maternal/prenatal programs.

5.3. Recognize and Remunerate Digital Care Work

Integrate household digital education management time into national time-use surveys. Local governments procuring e-learning devices should concurrently offer crash courses in digital literacy for women from underprivileged households, such as community night classes teaching WiFi configuration and assignment submission procedures. Public schools are progressively eliminating fragmented parent-school app assignments, integrating them into a unified platform with monthly operational time limits. A care labor credit bank system is being piloted, where mothers' participation in edtech training will be counted toward community education credits, exchangeable for childcare services.

6. Conclusions and Prospects: Education as a Re-mediating Force for Gender Equality

This study demonstrates that digital education technology has fallen short of its egalitarian promise. Rather, it has intensified gender inequality through institutionalized algorithmic bias, symbolic monopolization, and the invisibilization of labor. In the context of declining birth rates and population aging, this technological alienation significantly restricts women's development—mothers compromise career growth by assuming "digital domestic management", while older women face exclusion from digital learning opportunities. Consequently, educational equity becomes complicit in perpetuating technological elitism. The core contribution lies in advancing the "remediation" mission of education systems: rather than passively conforming to technological logic, education must actively embed it within a gender justice framework. Empirical evidence confirms the efficacy of institutional interventions: algorithmic audits demystify technological black boxes, anti-violence toolkits secure learning environments, STEM case quotas challenge symbolic monopolies, and digital labor metrics expose hidden exploitation. This transcends mere technical adjustments, representing a fundamental return to education's purpose—elevating human development above technological efficiency.

Against the backdrop of seismic demographic changes, this reform carries profound strategic implications: fostering fertility by reducing mothers' digital labor burdens, positioning education as cost-reducing infrastructure for childrearing; addressing aging through democratized age-friendly technologies to enhance senior women's welfare and mobilize their human capital; safeguarding technological equity by ensuring algorithmic justice, preventing female exclusion from the AI-powered future workforce. Its ultimate objective is to establish a lifelong learning ecosystem that integrates marriage and childbearing support, age inclusiveness, and technological equity, thereby embodying the digital era's ethos.

Note:

1. The “First-Level Digital Divide” in technology access was systematically conceptualized by scholars including Pippa Norris (2003) and Van Dijk (2005), denoting disparities among demographic groups in basic physical access to digital technologies. Its central concern revolves around the availability of technological devices, constituting the most elementary tier of the digital divide phenomenon.
2. The Third Shift, coined by American sociologist Arlie Hochschild (2001), describes the additional emotional labor women perform after completing paid employment (the first shift) and unpaid domestic work (the second shift). This encompasses emotional regulation (e.g., soothing family members), relationship upkeep (e.g., maintaining social connections), and self-presentation management (e.g., cultivating a “perfect mother” image). At its core, this phenomenon reflects how patriarchy tacitly designates emotional care as women’s domain.
3. A low-code development platform is a software development solution that facilitates rapid application construction via visual interfaces with minimal hand-coding. Its primary goal is to dramatically reduce programming complexity, empowering citizen developers to create applications while simultaneously boosting productivity for professional developers.

Disclosure statement

The author declares no conflict of interest.

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