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GLOBAL DIGITALIZATION AND WOMEN'S EDUCATION: CHALLENGES OF IMPLEMENTING THE INTERNATIONAL AGENDA IN CENTRAL ASIA

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Abstract. In the context of rapid global digitalization, ensuring equal access of women and girls to modern educational opportunities has become increasingly critical. Digital technologies are not only tools for acquiring knowledge but also decisive factors of socio-economic development, shaping both individual and national competitiveness. Central Asia including Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, and Turkmenistan, has formally committed to major international frameworks on gender equality in education, such as the UN Sustainable Development Goals (SDGs), the Beijing Platform for Action, and the CEDAW Convention. Nevertheless, the practical implementation of these commitments continues to encounter significant obstacles.

This article examines international policy documents defining the global agenda in digital education and women's rights and analyzes national strategies and legislative initiatives of the five Central Asian states. The findings reveal that, despite formal progress, several persistent challenges remain: insufficient digital infrastructure, uneven internet access between urban and rural areas, deeply rooted socio-cultural stereotypes that limit girls' professional trajectories, and institutional shortcomings in adopting and enforcing international standards.

A comparative analysis of the level of digitalization in the education sector and women's access to digital resources highlights key areas requiring urgent attention. The article formulates practical recommendations to reduce the digital gender divide, strengthen institutional mechanisms, and enhance the effectiveness of implementing international commitments in the region.

Overall, the study reflects the current state of the issue and emphasizes the need for a comprehensive approach that combines infrastructural, cultural, and governance measures to ensure that the digital era becomes one of equal opportunities for all, rather than a source of new inequalities.

Key words: digitalization, women's education, gender equality, Central Asia, international agenda, digital divide, Sustainable Development Goals (SDGs)

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Introduction

In the era of global digitalization, information and communication technologies (ICTs) are rapidly permeating all spheres of life, including education. Digital skills and access to online resources have become essential prerequisites for quality education and competitiveness in the labor market [1]. At the same time, the international community emphasizes the need to ensure that digital transformation does not exacerbate existing inequalities, especially gender-based ones. Historically, women and girls have faced discrimination in access to education, and today there is a risk that the «digital divide» between men and women may reproduce or even deepen these disparities [2]. Therefore, integrating the principles of gender equality into the digital education agenda has become critically important.

The Central Asian states, which inherited Soviet legacies of universal literacy and relatively high levels of women's education, on the one hand, have supported key international initiatives on women's rights. All five countries of the region ratified the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) and joined the Beijing Platform for Action of 1995 [3]. On the other hand, the transition to a digital economy and education has been accompanied by new challenges: insufficient infrastructure in remote areas, gender stereotypes regarding technology, disparities in digital skills, as well as institutional constraints. The COVID-19 pandemic starkly highlighted the vulnerability of education systems in the region, with up to 34% of students in Eastern Europe and Central Asia lacking access to distance learning during lockdowns [4], with rural girls being particularly disadvantaged [5].

The purpose of this article is to conduct a comprehensive study of how the global agenda on digitalization and women's education is being implemented in Central Asia, what barriers exist, and what measures are necessary to overcome them. To achieve this aim, the article addresses the following objectives:

To provide an overview of key international documents concerning digitalization and women's right to education.

To analyze the national strategies and legislation of Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, and Turkmenistan in the field of digital education and gender equality.

To identify the main infrastructural, socio-cultural, and institutional barriers that hinder the fulfillment of international commitments.

Comparing the levels of digitalization in the educational sector and women's access to digital opportunities across the region.

To develop recommendations for addressing identified barriers and ensuring more effective implementation of the international gender agenda in the digital education sphere.

Description of Materials and Methods

This study employs an analytical and comparative methodology to explore how global digitalization trends intersect with women's education in Central Asia. The analytical component involves a qualitative review of international

agreements, declarations, and policy frameworks relevant to gender, education, and technology. Key documents analyzed include United Nations treaties (such as CEDAW), global action plans (e.g., the 2030 Agenda and Beijing Platform for Action), and recent outcomes from international bodies (for example, the 2023 UN Commission on the Status of Women recommendations on gender and digital innovation). These texts are examined to identify the commitments and norms that Central Asian countries are expected to implement in advancing women's educational opportunities in the digital era.

In parallel, a comparative analysis is conducted across the five Central Asian republics. This involves comparing national policy documents, strategic programs, and statistical indicators to evaluate each country's approach and progress. Sources reviewed include government strategy papers on digital development and education, national gender equality action plans, and reports from international organizations (UN agencies, OSCE, World Bank) that provide country-specific data. By comparing metrics, such as female enrollment in ICT studies, digital literacy rates, and internet access gender gaps the study highlights similarities and differences in outcomes. The comparative method also extends to examining case studies and initiatives; for instance, evaluating how Kazakhstan's digital education initiatives contrast with those in its neighbors.

Data from scholarly research and official statistics are incorporated to support the analysis. Where available, quantitative data (e.g., percentages of women in STEM education or workforce) are used to illustrate points. The methodology is therefore interdisciplinary, combining elements of legal/policy analysis with comparative education and gender studies. This approach allows for assessing not only each country's internal progress but also how regional trends align with or diverge from global expectations.

International Frameworks: Digitalization, Education, and Women's Rights

The global normative framework encompasses a range of documents that directly or indirectly set out goals for digitalizing education and advancing women's rights. The most important among them are the United Nations Sustainable Development Goals (SDGs) 2030, the Beijing Declaration and Platform for Action (1995), and the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW, 1979), along with subsequent resolutions.

Sustainable Development Goals (SDGs). The 2030 Agenda for Sustainable Development established two goals of particular importance to this study: SDG 4 «Quality Education» and SDG 5 «Gender Equality». SDG 4 recognizes the right of every individual to inclusive and equitable quality education throughout life, while Target 4.5 specifically requires countries to «eliminate gender disparities in education and ensure equal access to education for vulnerable groups by 2030» [6]. Thus, the global framework confirms that eliminating the gender gap in education is a prerequisite for sustainable development. Meanwhile, SDG 5 is dedicated to achieving gender equality and empowering all women and girls, with Target 5.b calling to «enhance the use of enabling technologies, in particular information and communications technology, to promote the empowerment of

women» [7]. For the first time at such a high level, technological progress was explicitly linked with women's empowerment. The indicator for monitoring progress under SDG 5.b is the proportion of individuals who own a mobile phone, disaggregated by sex [7]. As of 2024, 77% of women worldwide owned a mobile phone compared to 82% of men, meaning women were 7% less likely to own one than men [7]. This data illustrates the persistence of the digital gender divide and highlights the continuing relevance of Target 5.b for all countries, including those of Central Asia.

Beijing Platform for Action (1995). Adopted at the Fourth World Conference on Women, the Beijing Declaration and Platform for Action remains a key reference point for global policy on women's rights. It identified 12 critical areas of concern, including «Education and Training of Women» and «Women's Empowerment». Although in 1995 digital technologies were only beginning to spread, the Platform already recognized technology as a crucial driver of women's rights [8]. In particular, the section on women and the media emphasized the need for equal access of women to new communication technologies. Today, three decades later, digital inclusion is regarded as essential for achieving gender equality [8]. Thus, the Beijing Platform laid the foundation for current initiatives aimed at ensuring women's participation in the digital economy and inspired the development of gender-sensitive technological programs.

CEDAW. The Convention on the Elimination of All Forms of Discrimination against Women (1979) is the primary legally binding instrument obligating states to eliminate discrimination on the basis of sex in all areas, including education. Article 10 of CEDAW guarantees women equal rights with men in education: equal access to all levels of education, vocational training, curricula, examinations, scholarships, and the removal of stereotypes through curriculum reforms [9]. For the Central Asian states, all of which have ratified the Convention (Tajikistan - 1993, Kyrgyzstan -1997, Kazakhstan - 1998, Uzbekistan -1995, Turkmenistan -1997), this implies a legal obligation to ensure full and equal participation of girls and women in education at all levels. In 2017, the CEDAW Committee issued General Recommendation No. 36 on the right of girls and women to education, clarifying that states should integrate gender perspectives into education strategies, including technical and digital training, and eliminate barriers from early marriage to gender stereotypes, that prevent women from pursuing education in new fields such as STEM (science, technology, engineering, and mathematics).

In addition to the aforementioned documents, the international agenda encompasses a number of specialized agreements and programs. For instance, the Education 2030 Agenda, enshrined in the Incheon Declaration (World Education Forum, 2015), proclaims gender equality as a central principle: countries agreed that «girls and boys, women and men not only gain equal access to all levels of education but are equally empowered through education» [6]. UNESCO's Strategy for Gender Equality in and through Education (2019-2025) likewise guides states toward transforming education systems, including closing gender gaps in acquiring science and technology skills [6]. The UN Commission on

the Status of Women (CSW), in its annual sessions, devotes particular attention to women and technology. Notably, the priority theme of the 67th CSW session (2023) was «Innovation, Technological Change and Education in the Digital Age for Achieving Gender Equality». The outcome documents of CSW-67 urge states to expand women's and girls' participation in STEM education, invest in their digital literacy, and remove barriers such as online violence and stereotypes that restrict women's participation in ICT. Thus, at the global level, a substantial body of benchmarks and commitments has been accumulated, requiring states including those of Central Asia to take active measures in ensuring equal opportunities for women in the digital era.

In summary, international norms clearly establish the interconnection between digitalization and women's right to education. The Central Asian states have undertaken these commitments, but the extent of their practical implementation depends on national policy. We now turn to how these international principles are reflected in the internal strategies and legislation of the five countries in the region.

Results and Discussion

National Strategies and Legislation on Digital and Women's Education

All Central Asian states declare the development of the digital economy and education, as well as the achievement of gender equality, as policy priorities, which are reflected in national programs and legislative acts. Below is a brief overview of the situation in each country, with attention to strategies for education digitalization and legal guarantees of women's equal access to learning.

Kazakhstan

In Kazakhstan, digital transformation has been proclaimed as one of the strategic directions of national development. The state program «Digital Kazakhstan» (adopted in 2017) covered the period up to 2022 and aimed at the accelerated introduction of digital technologies into the economy and social sphere [10]. Within the education sector, the program set a target for improving the population's digital literacy, including students and teachers. Parallel to this, the State Program for the Development of Education and Science until 2025 identifies education digitalization as a key priority: it envisages the broad provision of schools with computer equipment, connection to high-speed internet, and the development of distance learning and online resources.

According to national legislation, every citizen has the right to education, and gender-based discrimination is prohibited. In 2009, Kazakhstan adopted a special Law «On State Guarantees of Equal Rights and Equal Opportunities for Men and Women», which enshrined the principle of gender equality, including in education [4]. Current education legislation contains a clause guaranteeing equal access to quality education regardless of gender [11].

As a result of these measures, Kazakhstan has achieved near parity in women's participation in education: male and female youth are almost equally covered by secondary education, while in higher education the proportion of female students reaches 50% [11]. Moreover, in some respects women even

outpace men: for example, the share of women among master's and doctoral students is 1.7 times higher than that of men [11]. However, gender disparities remain in the choice of specializations. Women are still underrepresented in ICT and engineering fields. In 2020-2021, the number of men studying ICT disciplines was 2.2 times greater than that of women [11]. A similar pattern was observed in technical and engineering programs, whereas in pedagogy and social sciences women's share exceeded men's [11]. This «horizontal» inequality poses a challenge for policy: the government recognizes the need to encourage girls' participation in STEM. In recent years, with support from the UN and business, initiatives such as «Tech Girls» and «Digital Mom (IT-Äiel)» have been implemented, training women and girls in programming and digital skills [12]. Thus, Kazakhstan has institutionally established equal rights in education and is actively introducing digital solutions, while paying special attention to increasing women's involvement in high-tech sectors where they remain underrepresented.

Kyrgyzstan

In the Kyrgyz Republic, the digital agenda is enshrined in national development documents. The digital transformation program «Sanarip Kyrgyzstan» (Digital Kyrgyzstan) for 2019-2023 set the task of modernizing the economy and social sphere through ICT, including education [13]. At the same time, the Education Development Strategy until 2040 (EDS-2040) identified «education digitalization» as one of its main priorities [14]. This strategic document explicitly highlights the need to train all participants in the educational process in digital skills, to create a unified electronic educational environment, to implement distance learning technologies, and to develop an Education Management Information System (EMIS) [14]. Expanding distance learning and supporting electronic resources are viewed as key conditions for ensuring access to school education for all [14].

The Law of the Kyrgyz Republic «On Education» (amended in 2022) legalized distance learning at all levels as an equal form, granting students in remote learning the same rights and diplomas as those in full-time education [14]. This proved particularly relevant during the COVID-19 pandemic, when schools were forced to move online.

Regarding gender equality, the Constitution of Kyrgyzstan and the Law «On the Basic Guarantees of Gender Equality» (2008) proclaim equal rights for men and women. Women in Kyrgyzstan enjoy almost the same levels of literacy and education coverage as men: as noted by UNDP, the country «has achieved gender parity in educational coverage and literacy levels» [1]. In primary and secondary school, the share of boys and girls is approximately equal, while in higher education parity is also observed (UNESCO data show gross enrollment in higher education at 28% for both men and women) [6].

Nevertheless, problems of «gender segregation» in specializations and subsequent labor market mismatches persist, similar to Kazakhstan. Men predominate in technical universities, while women more often choose humanities and social sciences. Moreover, early marriage and the practice of bride kidnapping (ala kachuu), especially in rural areas, continue to hinder girls' completion of

secondary and higher education [3]. According to OECD estimates, around 20% of girls in Kyrgyzstan leave education due to early marriage [4]. The government acknowledges this problem and, in cooperation with the UN and NGOs, has taken steps to address it, including strengthening penalties for forced marriage and conducting awareness campaigns.

Given limited resources, Kyrgyzstan relies heavily on international support in the area of digital learning. For example, the European Union finances programs for developing digital and media literacy among youth and reducing educational inequalities [15]. UNICEF supports the transformation of rural libraries into centers of digital learning for preschoolers [16]. Thanks to such efforts, as well as a relatively liberal information policy (compared to some neighbors), internet penetration in Kyrgyzstan has grown rapidly in recent years: by 2022, 80% of the population were internet users [17]. According to ITU, internet penetration rose from 45% in 2017 to nearly 80% in 2022 [18], creating favorable conditions for the wider introduction of digital learning.

Uzbekistan

In recent years, Uzbekistan has witnessed an active process of digital modernization, initiated through reforms. President Shavkat Mirziyoyev has proclaimed the course toward building a «New Uzbekistan», in which the program «Digital Uzbekistan-2030» constitutes an integral part. This national strategy, adopted in 2020, is aimed at the comprehensive development of digital infrastructure, e-government, and digital skills among the population [19]. In the field of education, Uzbekistan prioritizes the integration of ICT into schools and universities and the development of online platforms. As early as 2002, a program for the informatization of education had been introduced, and by the 2020s new targets were set to bring school equipment and internet access to modern standards (in earlier strategies, the goal had been to provide internet access to 63% of schools a benchmark already surpassed) [20].

In partnership with international organizations, innovations are being piloted: for instance, with UNICEF's support, an Innovation Center for Education was created to test digital solutions for improving student performance [21]. A key priority is improving teachers' ICT qualifications [22]. For this purpose, experts are invited and training programs conducted (e.g., in 2022, UNESCO engaged specialists to train teachers in digital technologies [22]).

Uzbekistan's legislative framework regarding women's rights has also undergone positive changes in recent years. In 2019, the Law «On Guarantees of Equal Rights and Opportunities for Women and Men» and the Law «On the Protection of Women from Oppression and Violence» were adopted. In 2022, the National Strategy on Gender Equality until 2030 was approved, with implementation carried out in cooperation with UNDP and other international partners [23]. These documents include provisions on promoting women's education, particularly in technical fields, and on eliminating stereotypes.

Formally, women in Uzbekistan enjoy equal access to education, and in practice, the enrollment of girls in schools is nearly universal; literacy rates among women are as high as among men [20]. According to the U.S. Embassy, «women

and girls in Uzbekistan enjoy equal access to education: in 2017, girls constituted 50% of primary school students and 54% of secondary school students» [20]. This demonstrates the preservation of universal education for girls. Moreover, a significant share of women pursue higher education. However, as in neighboring countries, a gender gap remains in digital skills and participation in high-tech sectors. A UNDP study (2022) confirmed the existence of a «gender digital divide» in Uzbekistan: women's digital skills were 24% lower than men's. On average, women are less likely to possess advanced ICT competencies, with the gap especially pronounced among older users (women over 35 had 10% fewer ICT skills than younger women) [23].

Women are also underrepresented in IT specializations: as of 2021, only 17.8% of ICT graduates in Uzbekistan were female. Thus, young Uzbek women remain insufficiently engaged in shaping the digital economy. The state seeks to address this situation by creating technology parks and training programs for girls (e.g., Technovation Girls and IT start-up competitions for women [23]). A presidential decree in 2022 introduced quotas for girls from low-income families when applying to technical universities. Campaigns are also conducted to counter stereotypes that «technology is not for women»: open discussions featuring female ICT leaders have become part of celebrations for the International Girls in ICT Day [23].

In sum, Uzbekistan recognizes in its strategic documents both the necessity of digitalizing education and the importance of gender equality. However, overcoming historical stereotypes and skill gaps requires continued efforts.

Tajikistan

For Tajikistan the least economically developed state in the region, the task of digitalizing education is coupled with serious infrastructural and staffing challenges. Nonetheless, at the highest level the course toward a digital economy has been declared: beginning in January 2025, the period «Years of Development of the Digital Economy and Innovation, 2025-2030» was officially launched by presidential decree [5]. The government has elaborated a Concept for the Transition to Digital Education and a National Education Development Strategy 2020-2030, which envision the expansion of digital learning and distance formats [5]. These documents acknowledge that distance education can simultaneously advance digitalization and accessibility for all-including girls. Yet, in practice, during the COVID-19 pandemic Tajikistan made little use of distance education, and thus these policies have not been tested [5].

Unlike its neighbors, Tajikistan did not close schools for extended periods in 2020-2021 (officially citing the absence of registered COVID-19 cases until mid-2020), and thus a mass transition to online classes did not occur. However, persistent problems of digital underdevelopment remain evident: in 2021, Tajikistan ranked 129th in the world for mobile internet speed and 104th for fixed broadband, making it one of the least connected countries [5]. High connection costs and a shortage of technical equipment are especially acute in rural and mountainous areas.

The legal framework of Tajikistan guarantees women equal rights: the Constitution proclaims equality, and the Law on Education prohibits discrimination. Nonetheless, estimates suggest that up to half of young women in Tajikistan are not engaged in either education or employment often due to early marriage and childbearing [4]. OECD notes that 52% of Tajik women aged 18-24 fall into the NEET (Not in Employment, Education, or Training) category, compared with 30% of men [4]. Traditional norms exert a strong influence: a significant portion of the population (37% in Central Asia) believes higher education is more important for sons than for daughters [4]. Domestic responsibilities disproportionately fall on women: 20% of young women in Central Asia are excluded from education or work due to household duties and caregiving, compared to only 2% of men [4].

These tendencies manifest in the digital era as well. During the pandemic, when learning moved to the home, 40% of girls reported difficulty balancing study with household tasks, compared to 29% of boys [4]. In remote areas of Tajikistan, when attempts were made to organize online classes, only 20% of students could continue learning digitally; the rest lacked internet access or devices [4]. The burden was particularly heavy on girls: a recent survey found that 65% of female students in rural Tajikistan reported that household responsibilities prevented them from using online educational resources (compared to 40% of girls in urban areas) [5]. This disparity underscores that rural girls are in the most disadvantaged position within the digital education system.

Recognizing these challenges, the government plans significant investments in infrastructure (expansion of broadband, subsidized mobile internet), school equipment, and most importantly teacher training. Currently, many Tajik teachers are unprepared for digital education: in the capital Dushanbe, 56% of teachers had internet access, while in some regions only 9-25% could connect at work [5]. Even schools that received computers often failed to use them effectively due to lack of skills and maintenance.

In response, the government, with donor support (World Bank, GPE, UNICEF), is implementing programs to improve teachers' ICT competencies and develop online platforms. A special emphasis is placed on the principle of «equity at the center of digital education strategies» [5]: new initiatives must address the needs of vulnerable groups such as girls, minorities, and rural youth. Proposed measures include subsidized internet for girls, provision of devices to low-income female students, and localization of content into minority languages. In 2023, Tajikistan launched a pilot project with support from GPE and EdTech Hub to integrate technology into schools and exchange experiences with other countries [5].

Thus, although Tajikistan lags in many respects, it demonstrates political will and has begun systemic reforms which, with adequate funding, could reduce the digital divide including the gender divide in the coming years.

Turkmenistan

Turkmenistan represents the most closed and distinctive case in the region. Official state ideology proclaims the priorities of science, education, and progress.

The State Program for Education Development aims to modernize the system, introduce innovative technologies, and train young cadres skilled in IT [24]. A unified electronic education portal for schools and universities has been created [25] particularly relevant during the COVID-19 pandemic, when the need for remote learning also arose in Turkmenistan [26].

However, the real level of education digitalization remains low due to extremely weak internet infrastructure and strict state control over online access. Turkmenistan is among the least connected countries in the world: according to the World Bank, only around 21% of the population used the internet in 2019 [27]. Internet service is expensive, speeds are low, and many international resources are blocked. Under such conditions, mass online learning is hardly feasible: during the 2020 lockdowns, schools largely resorted to traditional methods (distribution of printed materials) rather than internet-based instruction [26].

The government nonetheless reports steps toward digitalization: for example, introducing bans on mobile phones in classrooms (to improve student focus) [28], while simultaneously equipping schools with computer labs through international projects (e.g., the EU BOMCA program supplied a border school with computers and an interactive panel [29]).

Regarding women, Turkmen society is patriarchal, but formally women have equal rights. Turkmenistan ratified CEDAW in 1997 and legally prohibits discrimination. Girls are almost universally enrolled in secondary education, and female literacy is close to 100%. Yet women's broader status is marked by contradictions: on the one hand, relatively high female representation in education and even politics (women comprise 24.8% of the Mejlis deputies [30]); on the other, strong traditional norms emphasizing women's roles within the family. According to UNICEF, 89% of the population believes that children should be raised primarily by mothers, with fathers and kindergartens playing a secondary role [30]. This leads to a double burden on women, limiting their educational and career development.

Digital skills among women remain underdeveloped: a 2019 survey found that only 34.9% of girls and young women possessed at least one ICT skill [30]. By contrast, nearly 95% of women aged 20-24 used a smartphone at least once a week, but mainly for basic purposes (calls, messaging) [30]. Thus, digital literacy requires improvement. The government has declared commitment to closing the gender digital divide: in cooperation with UNDP, projects are being implemented to train women in IT competencies [31]. Nevertheless, progress is constrained by the overall state of internet freedom; as long as online access remains a luxury, genuine digital education and equal opportunities for women remain unattainable.

That said, in its international reporting, Turkmenistan regularly highlights successes: for example, citing legal guarantees of equal access to education for men and women, and the absence of a gender gap in school enrollment. These statements are factually correct in terms of numbers boys and girls attend school in equal proportions but they do not reflect the quality of access, particularly to digital opportunities.

In conclusion, Turkmenistan formally supports the international agenda but lags furthest behind among the five countries in its actual implementation, especially in terms of digitalization.

Comparative Summary of National Overviews

Across all Central Asian states, formal commitments exist to gender equality in education and to digital transformation, with these priorities integrated into strategies and legislation. Kazakhstan, Kyrgyzstan, and Uzbekistan have adopted extensive programs for education digitalization, encompassing ICT training, online learning, and school equipment [5]. These same countries also have gender equality strategies or laws (e.g., Kazakhstan's Law on Equal Opportunities, Uzbekistan's National Gender Equality Strategy, Kyrgyzstan's National Plan on Gender Equality). Tajikistan and Turkmenistan, despite more limited resources, likewise declare digitalization and women's rights as priorities and adopt relevant concepts and programs.

However, the existence of strategies does not equate to their full realization. The next section will analyze the challenges and barriers that hinder the achievement of stated goals in practice.

Challenges and Barriers to Implementing the International Agenda in the Digitalization Context

The implementation of international commitments (such as SDGs 4 and 5, the Beijing Platform, and CEDAW) in the Central Asian states encounters a complex set of problems. These challenges may be grouped into:

- Infrastructural and technical (related to access to digital technologies),
- Socio-cultural (linked to societal attitudes and gender norms),
- Institutional and legal (related to policies, governance, and legislation).
- Infrastructural and Technological Barriers.

Uneven access to internet and equipment. One of the primary obstacles is the underdeveloped state of digital infrastructure, especially outside major cities. While capitals and large urban centers in Central Asia are relatively well connected, rural areas lag significantly behind. For example, in Kazakhstan internet penetration is estimated at about 90% of the population overall, but connectivity and quality remain much lower in rural regions, limiting access to online education for many rural residents (half of whom are women) [2]. Studies show that only one-third of rural schools in Kazakhstan are equipped with basic computer technology, and many face acute shortages of both computers and internet access [10].

Similarly, in Kyrgyzstan and Tajikistan, many remote schools lacked stable connections at the beginning of the 2020s. During the pandemic, around 70% of students in Tajikistan's rural areas were deprived of reliable internet access [5], making distance education inaccessible for most. In Uzbekistan, despite state efforts to increase the number of schools with internet access, connection quality and speed often remain insufficient for video lessons, particularly outside Tashkent. Turkmenistan remains among the least connected countries globally, with only 21% of the population online [27], the majority in the capital Ashgabat.

High costs and technical constraints. Even when technically available, internet access is often prohibitively expensive. In low-income families, priority access to computers or phones may be granted to sons (for university or work purposes), while daughters' access is restricted. This is indirectly reflected in global statistics: as of 2024, women were 7% less likely than men to own a mobile phone [7]. In Central Asia, mobile internet has played an outsized role due to relatively good cellular coverage, yet traffic costs remain a barrier, especially for data-intensive content such as online lessons. In Tajikistan, during the COVID-19 lockdowns, many students relied only on smartphones; however, high mobile internet costs and the absence of adequate learning apps severely limited their use for educational purposes [5]. Device shortages present another issue: multiple children may share a single phone, or households may lack any computer at all. Girls often receive less screen time under these conditions, as priority is given to brothers or other family members.

Insufficient school equipment. School infrastructure in many places remains unprepared for digital education. There are cases where even supplied equipment remains unused. In Tajikistan, some schools receiving computers failed to implement them due to a lack of maintenance staff and teacher training [5]. In Kazakhstan, studies of rural schools revealed an «acute shortage of modern equipment», with many relying on outdated computers incapable of supporting new software [10]. Unreliable electricity and connectivity in remote areas further disrupt online classes. Such disparities exacerbate educational inequality between urban and rural students a problem with a gender dimension, given that girls are more likely to remain in rural areas (while young men often migrate to cities for study or work).

Cybersecurity and digital safety. Another dimension concerns the absence of a safe online environment. Parents and teachers in the region often express concern that the internet poses risks for girls, including exposure to harmful content, online violence, or fraud. In societies with traditional values (e.g., Turkmenistan, parts of Uzbekistan and Tajikistan), this sometimes leads to restrictions on girls' internet access «for their own protection». A lack of digital safety skills compounds the problem: users are often unaware of how to protect their data, leading to distrust of technology. In Kazakhstan, policymakers stress that digital integration must go hand-in-hand with digital safety; otherwise, the benefits of technology risk being undermined [2]. Women in particular face heightened vulnerability to online risks (gender-based cyberbullying, harassment), which may serve as further barriers to their full use of digital opportunities.

Summary. Infrastructural limitations the «hard» digital divide manifest in connectivity and equipment shortages, disproportionately affecting rural women. Without addressing these deficits (through network expansion, subsidized access, and better school equipment), the international goals of education for all and women's digital empowerment remain difficult to achieve.

Socio-Cultural Barriers

Gender stereotypes and traditional norms. Social attitudes largely determine the extent to which girls can take advantage of new educational

opportunities. In Central Asia, despite women's relatively high levels of basic education, patriarchal views on women's roles persist especially in rural areas and traditional families. From an early age, girls may receive the message that success in science, mathematics, or technology is «not for women». Studies show that stereotypes about what activities are suitable for boys versus girls are already formed in preschool [2]. At school, this is reflected in the belief among both students and often teachers that boys are more inclined toward mathematics and technical subjects, while girls are better suited for the humanities. Such assumptions influence self-esteem and career choice. As a result, women are underrepresented in STEM disciplines: for example, in Kazakhstan, fewer than 32% of students in ICT programs are female [1], while in Uzbekistan the figure is even lower at about 18% [1].

Stereotypes are also reinforced by educational content: an analysis of Kazakhstani school textbooks revealed an extremely limited representation of female characters in physics, computer science, and similar subjects [2]. This fosters the perception among girls that science and technology are male-dominated fields. There are also too few role models: although female engineers and programmers do exist, their visibility in the public sphere is limited. Overcoming this barrier requires efforts to revise teaching materials and promote examples of women in science and IT. Initiatives such as WikiGap, supported by UNESCO, which aims to fill Wikipedia with articles on outstanding women across fields, illustrate such efforts [32].

Priority of family responsibilities. In the region's traditional culture, women are expected to prioritize their roles as wives, mothers, and homemakers. This directly shapes educational trajectories. Girls may be implicitly or explicitly encouraged to view higher education as less important than marrying and bearing children at the «right» time. As a result, some families stop investing in daughters' education after secondary school. Early and forced marriages still occur, especially in rural communities. In Kyrgyzstan, UN estimates suggest that 13.8% of girls under 24 have been subjected to bride kidnapping [3], despite its illegality. In Tajikistan, around 7% of girls marry before the age of 18 [3]. In Uzbekistan and Kazakhstan early marriages are officially less common, yet social pressure persists in rural areas for example, the belief that an unmarried woman over 23 is «overdue» [3]. Consequently, early marriage often leads to interrupted education, with young women abandoning studies and failing to obtain university degrees. Even when secondary education is completed, family pressures may prevent girls from enrolling in higher education. This dynamic contributes to men having higher average levels of tertiary and vocational education than women though Kazakhstan is an exception, where female enrollment slightly exceeds male enrollment, due to urban middle-class dynamics and policies supporting women's education [11].

Under conditions of digital learning, family duties become an even greater obstacle for girls. In traditional schooling, girls at least spend time outside the home, whereas in distance learning settings they are often expected to supervise younger siblings or perform household chores during lessons. The COVID-19

pandemic exposed this issue starkly: according to UNESCO surveys, 40% of girls in the region reported difficulties balancing online study with household duties, compared with 29% of boys [4]. Older girls were often expected to cook or clean while parents worked, while boys were more often allowed to concentrate on lessons. In Tajikistan, the rural-urban divide is evident: 65% of rural girls, compared to 40% of urban girls, reported that domestic responsibilities prevented them from using online resources [5]. Thus, traditional gendered divisions of labor negatively affect girls' education, particularly in remote learning formats.

Social expectations and the «brain drain». Even after obtaining education, women do not always realize their professional potential due to societal pressure. In some communities, it is frowned upon for married women to pursue careers outside the home. This indirectly undermines the motivation to pursue higher education in the first place: why spend years at university if one is expected to stay at home? Such attitudes are especially common in more conservative areas of Uzbekistan, Tajikistan, and Turkmenistan. UNDP notes that «Central Asian women, even when educated, often drop out of economic activity to stay at home caring for children». Female labor force participation is consistently lower than men's: in Tajikistan, for instance, only about 29% of women are economically active, compared to 67% of men [33]. Domestic responsibilities play a key role in this imbalance. This reduces the returns on investment in women's education and reinforces the perception in some families that «basic education is enough for girls, the rest is family».

Resistance from conservative groups. In several countries, initiatives promoting gender equality have faced opposition. Feminist events or even discussions of sexual education may be criticized or banned under pressure from religious or nationalist groups. In Kazakhstan and Kyrgyzstan, peaceful women's rights marches have at times been dispersed [3]. This creates an atmosphere in which teachers may hesitate to openly discuss gender equality or promote «non-traditional» ideas, such as encouraging girls to code or participate in hackathons for fear of backlash from parents. Consequently, progressive initiatives to expand girls' participation in technology may lack broad social support.

Despite these negative factors, there are also positive shifts. The younger generation increasingly recognizes the value of education for all, regardless of gender. In Kazakhstan, for instance, the gender gap in education is minimal, and society broadly accepts women's careers. In Kyrgyzstan, active women's organizations promote girls' rights to education and professional choice. Uzbekistan in recent years has lifted certain informal restrictions on women, such as easing procedures for female students to study abroad. Social and cultural norms are thus gradually transforming, particularly under the influence of globalization and the internet. Accelerating this process is crucial, as without changes in social consciousness, even robust infrastructure will not eliminate barriers to women's participation in the digital sphere.

Institutional and Political Barriers

The gap between policy and implementation. As shown, all Central Asian states have adopted strategies and laws declaring support for education

digitalization and gender equality. The challenge lies in execution and monitoring. Strategic documents sometimes remain on paper due to resource shortages, bureaucratic delays, or insufficient interagency coordination. For example, in Tajikistan, policies on distance learning existed for years, yet no meaningful steps toward implementation were taken until the pandemic [5]. In Uzbekistan, the National Gender Equality Strategy has been adopted, but its provisions such as addressing stereotypes in schools will require sustained effort before they are widely realized.

Insufficient funding and investment. Digitalizing education is costly. It requires procurement of equipment, infrastructure development, teacher training, and digital content creation. Not all regional governments allocate sufficient funds. Education spending as a percentage of GDP in Tajikistan and Turkmenistan is among the lowest in Eurasia, hindering innovation. As a result, many schools have not updated computer equipment in over a decade. Gender equality programs are also often underfunded. Although SDG 5.c calls on countries to establish tracking and financing systems for gender equality [7], in practice budget allocations for concrete measures (such as scholarships for girls in IT) remain small. International donors partially fill these gaps (e.g., World Bank grants for digitalizing schools in Uzbekistan, EU projects in Kyrgyzstan and Tajikistan), but sustainability depends on governments' willingness to maintain funding once grants end.

Lack of expertise within education governance. Administrators and educators responsible for implementing digital and gender agendas themselves often need capacity-building. Many officials from the «old school» may not fully appreciate the importance of gender perspectives or the specifics of digital education. This can lead to misplaced priorities: for instance, focusing solely on purchasing equipment (to «tick a box») without developing pedagogical methods for its use particularly in engaging girls. Horizontal coordination between ministries of education, ICT, labor, and women's committees is also sometimes inadequate. Uzbekistan offers a positive example: discussions on the gender digital divide involved the Ministry of Digital Technologies, Ministry of Education, the Women's Committee, and others jointly [23]. Such integrated approaches, however, remain exceptions rather than the rule.

Insufficient gender-disaggregated data and monitoring. Effective policy requires data on where and how inequalities manifest. Yet, not all countries systematically collect statistics on gender gaps in internet use, digital skills, or participation in distance learning. Without such data, progress on SDG 5.b is difficult to track. A positive example is UNDP's recent gender digital divide assessment in Uzbekistan, which provided concrete figures on women's lag [23]. Similar studies are needed in other states. Official statistics often focus only on aggregate indicators (e.g., internet penetration, number of computers per 100 students), without gender breakdowns. Consequently, gender nuances may remain invisible and unaddressed in policymaking.

Legal barriers and internet censorship. Another institutional factor concerns states' broader internet policies. Here the differences are stark: in Kazakhstan,

Kyrgyzstan, and (more recently) Uzbekistan, internet access is relatively open, whereas in Turkmenistan and, to some extent, Tajikistan it is heavily restricted. Blocking of resources, VPNs, and other tools limits educational opportunities. For instance, if YouTube or similar platforms are inaccessible, students lose access to vast repositories of educational videos. In Turkmenistan, a kind of «cyber-isolation» places students at a severe disadvantage compared to the outside world. While this is primarily a political issue, it directly affects the implementation of international agendas: how can SDG 5.b (women's digital empowerment) be fulfilled if digital technologies themselves are available only to a privileged few?

Institutional biases. Beyond formal laws, informal practices persist. For instance, universities and vocational schools may lack programs encouraging girls to pursue technical fields. Career counseling in schools may continue to direct girls into «traditionally female» professions (teaching, medicine, services) rather than IT. Instances of discrimination in hiring or internships in IT companies against women (e.g., questioning their competence) also occur. Such practices diminish girls' motivation to study ICT. Government institutions should lead by example appointing women to head digital projects, creating flexible working conditions for female programmers with children, etc. Without such measures, well-intentioned declarations risk remaining empty rhetoric.

Overall, institutional barriers in Central Asia are systemic in nature: policies on digitalization and gender equality have not yet become truly «mainstreamed», permeating all decision-making processes. However, there are signs of positive shifts. For example, Kazakhstan's introduction of a 30% quota for women and youth on electoral lists indicates recognition of the need for institutional mechanisms of equality [11]. A similar approach could be applied to education for instance, introducing targeted quotas or programs to increase the share of girls in IT courses, and monitoring the fulfillment of these goals by ministries.

The challenges analyzed are interrelated and often mutually reinforcing. Weak infrastructure amplifies the effects of social factors (e.g., if a household has only one computer with a poor internet connection, the son is more likely to use it for his studies, while the daughter is left without access). Social stereotypes, in turn, can serve as implicit justifications for insufficient investment («why spend money on a digital lab for a rural school if the girls will marry early anyway?»). Successful implementation of the international agenda therefore requires simultaneous action to address barriers in all dimensions technical, cultural, and institutional. Before moving to recommendations, it is important to compare how the Central Asian states rank against one another across key indicators of education digitalization and women's participation.

Comparative Analysis of Central Asian Countries

The five Central Asian states demonstrate both commonalities shaped by their shared history and notable differences in the levels of digital infrastructure, population education, and women's status. To identify priorities, it is important to compare several indicators: internet access, the spread of digital learning, women's participation in education (in general and in STEM), women's digital skills, and the countries' positions in relevant international rankings.

Internet access and connectivity. Based on internet penetration, the states can be divided into three groups:

Leaders: Kazakhstan and Kyrgyzstan. Kazakhstan has the highest proportion of internet users variously estimated between 81% and 90% of the population [2]. These high levels are largely due to developed urban infrastructure (penetration in cities is close to 100%) and state policies to expand access (e.g., projects to extend broadband to 250+ rural settlements). Kyrgyzstan has also shown a sharp rise: by 2022, around 80% of citizens used the internet [2], [17]. This growth is explained by the rapid expansion of mobile internet; in terms of mobile subscriptions per capita, Kyrgyzstan has caught up with its neighbors. Thus, Kazakhstan and Kyrgyzstan are nearly on par in terms of network accessibility.

Middle performer: Uzbekistan. Here, a clear majority has internet access, though not at the same level as Kazakhstan. Estimates vary: officially about 71% of the population were online in 2023 [34], while independent sources put the figure closer to 60-65%. The urban-rural divide remains large: in Tashkent and provincial centers nearly all young people are connected, while access in remote kishlaks is still limited. However, implementation of the Digital Uzbekistan 2030 strategy has already led to cheaper and more widespread mobile internet. In 2022, Uzbekistan entered the global top five countries for internet audience growth. This suggests that it will likely catch up with neighbors in the near future.

Laggards: Tajikistan and Turkmenistan. Tajikistan long ranked last in the region: in 2019, only 26% of the population had internet access, and even by 2023 the rate was only 35-40% [4]. The main causes are mountainous geography, poverty (fewer smartphones), and expensive traffic. Still, progress is visible: operators are extending 3G/4G networks into mountainous areas, and prices are slowly falling. Turkmenistan remains one of the world's most disconnected countries: just 21% of the population used the internet in 2019 [27], and by 2023 the figure was no higher than 30%. Moreover, internet quality is extremely poor, with speeds dozens of times below global averages. Turkmenistan is the only country in the region not directly connected to major internet backbones, relying instead on routes via Russia or Iran, which limits bandwidth. Thus, the regional digital divide between leaders (Kazakhstan) and laggards (Turkmenistan) amounts to around 60 percentage points in population coverage.

Women's access to digital opportunities. Beyond overall access, gender gaps within each country reveal how equally women benefit from connectivity compared to men. Available data show:

Kazakhstan: The situation is close to parity. Official figures indicate that women constitute 51% of internet users [2]. Given that women make up 52% of the population, representation is virtually equal. Women are active online, widely adopting social networks, messaging apps, and services. Thus, the gender gap in access is minimal (a few percentage points, if any).

Kyrgyzstan: Women are reported to account for more than half of social media users (53-57% in different years) [35]. Likely, women's share among internet users is close to their population share (~50%). Earlier surveys noted gender gaps, especially among older age groups (e.g., in 2018, only 25% of

women respondents used the internet compared to 32% of men [36]), but this may now be outdated. With mobile internet widely available, and overall penetration at 80%, women's usage is likely similar (UN Women data show 75% of rural women online compared to 78.6% of men, a ~3-point gap [37]).

Uzbekistan: Precise gender-disaggregated data are limited. However, UNDP estimates suggest women's digital skills are 24% lower than men's [23], implying less active use. GSMA has noted significant mobile internet gender gaps in South Asia, though Uzbekistan is closer to its Central Asian peers. Women likely lag men by 5-10 percentage points in internet use, with young men more likely to own smartphones. Nevertheless, state support is helping to narrow the gap.

Tajikistan: Gender gaps are more pronounced. Young men own mobile phones and gain internet exposure while working abroad, whereas many rural girls lack smartphones. A 2019 USAID survey showed that among Tajiks aged 15–24, 37% of young men and only 30% of young women used the internet a 7-point difference [36]. The gap is larger among older cohorts. Women are thus significantly less connected.

Turkmenistan: No official data are available, but reports indicate that women actually outnumber men among social media users (54.7%) [35]. This may reflect men's reluctance to appear online under state surveillance, while women are more active in permitted areas (e.g., cooking, fashion, communication). However, given the small overall user base, this cannot be equated with equal opportunities. In urban areas, young women likely use the internet as much as men, but in rural areas neither group has significant access.

We compare the five Central Asian countries on digital connectivity and gender parity. Table 1 summarizes key metrics: internet usage, mobile subscriptions, and the Global Gender Gap (GGG) score (higher = greater parity).

Table 1 - Digitalization and Gender Equality Indicators in Central Asia (2023–2024)

Country	Internet Users (% of population)	Mobile Connections (per 100 population)	Global Gender Gap Score (2024)
Kazakhstan	90.9 %	130.5	71.0 %
Kyrgyzstan	77.9 %	161.4	70.0 %
Uzbekistan	76.6 %	91.2	68.1 %
Tajikistan	40.8 %	102.0	67.3 %
Turkmenistan	38.2 %	77.0	- (data unavailable)

(compiled by the authors, Sources: Gender Gap…[4])

Level of Education Digitalization

Kazakhstan: the most advanced. Almost all schools have computers, and the majority are connected to the internet. By 2021, 100% of schools had network access (though at varying speeds). During the pandemic, Kazakhstan transitioned relatively quickly to distance learning, using the national Online Mektep platform and televised lessons. Problems existed especially in rural schools but

overall preparedness was higher than that of its neighbors. The state continues to invest: for example, in 2022 it planned to provide high-speed internet to 90% of rural schools. However, only about one-third of rural schools had a full set of equipment [10], indicating that further improvements are needed.

Kyrgyzstan: a medium level of digitalization. Before COVID-19, distance learning was not widespread. By 2020, only 60% of schools were connected to the internet, and on average there was one computer for every 30 students. During the pandemic, Kyrgyzstan faced difficulties: 34% of students (according to the Eastern Europe and Central Asia region) lacked access to remote learning [4]. Afterwards, the government, with donor support, accelerated reforms, introducing electronic gradebooks and online platforms. Nonetheless, the digital divide between urban and rural areas remains significant: schools in Bishkek and Osh are better equipped, while mountain villages often lack facilities altogether.

Uzbekistan: rapid growth. Whereas previously not all schools had internet access, authorities now claim that practically all schools are connected. Uzbekistan has invested in IT classrooms and launched the «One Village - One Wi-Fi» project for schools. The 2020 lockdown spurred the introduction of televised lessons and the Eduuz online portal. Problems remain: overcrowded classrooms and insufficient equipment for all students. In urban areas, however, many pupils own smartphones, enabling teachers to use messaging apps for learning. A specific gender aspect is evident: women account for over 70% of teachers in primary schools, yet older female teachers are often less confident in using computers than younger male IT instructors. This feminization of the teaching workforce, combined with low ICT skills, may slow digitalization. The government is addressing this by offering ICT training for teachers.

Tajikistan: low level. Until recently, in most rural schools, only administrators had a computer and often without internet. As noted, more than half of teachers in cities had internet access, but in rural districts fewer than a quarter did [5]. Many rural students had never used a computer. Consequently, digital literacy among graduates is very low, especially among girls (who are less likely than boys to gain exposure to computers at home, e.g., through gaming). With international support, Tajikistan has begun equipping schools «from scratch», but the task is immense.

Turkmenistan: officially, all schools are equipped with multimedia classrooms, but in practice equipment in rural schools is often outdated and without real internet access (only local intranet resources). Turkmenistan announced the creation of an e-school, but internet censorship prevents the use of global platforms. Universities are permitted internet access only in closed computer labs with filtering. Thus, digitalization is tightly controlled, diminishing its effectiveness.

Women in Higher Education and Science

It is instructive to compare women's shares at the tertiary level:

Kazakhstan and Kyrgyzstan: women are either the majority or close to parity in universities. In Kazakhstan, ~55% of students are women; in Kyrgyzstan, ~50% [11]. This reflects the legacy of universal access and relatively liberal social

norms: families are willing to educate daughters, and many young women seek higher education. However, significant imbalances persist in technical fields: in ICT, men account for ~70% of students and women 30%, while in education the proportions are reversed (70% women, 30% men) [11].

Uzbekistan: historically, female enrollment was lower (especially in the 1990s), but the situation has improved. By 2022, women made up over 38% of students, with numbers rising as higher education expands (new university branches, incentives for rural girls). Authorities actively promote female participation: for example, rural girls entering universities receive additional scholarships. Yet women remain underrepresented in technical institutions.

Tajikistan and Turkmenistan: female enrollment is generally below 40%. In Tajikistan, male labor migration (many young men work abroad) increases the relative share of women in local universities, but early marriage offsets this effect. In Turkmenistan, traditional norms also limit higher education: although many girls finish school with high marks, a significant portion marry early. Access to universities is further constrained by competitive exams and corruption, where boys may be favored. No exact statistics are available, but indirect estimates suggest women make up ~30% of researchers in Turkmenistan and just over one-third in Tajikistan.

Digital Skills and Participation in the ICT Sector

According to UNDP, gender gaps in digital skills exist across all countries in the region, though their magnitude varies. In Uzbekistan, men's digital skills exceed women's by 24% [23]. Kazakhstan lacks precise figures, but given near-parity in internet access, the gap is likely smaller. Still, women comprise only 15-20% of IT-sector workers (with indicators suggesting women's share of the STEM workforce is around 28%) [2]. In Kyrgyzstan, the estimated gender gap in digital literacy is 7-10%, while in Tajikistan it may exceed 10%.

Women entrepreneurs in ICT remain few, though success stories exist female founders of start-ups in Kazakhstan, or a young woman in Uzbekistan winning an innovation contest. Structurally, however, women are underrepresented in tech business. A 2022 study showed women in Central Asia to be significantly underrepresented among founders and investors in Web3 companies [2]. This is a global trend but is accentuated in the region. Nonetheless, progress is evident: communities such as Women Techmakers (a Google initiative, with a representative in Turkmenistan) [1] and Girls in Tech clubs have emerged.

International Indices

Global Gender Gap Index (World Economic Forum, 2023): Kazakhstan ranked 65th (of 146), Kyrgyzstan 95th, Uzbekistan 120th, Tajikistan 136th, while Turkmenistan was not ranked (no data, though prior estimates placed it 130-140). These positions reflect overall gender equality progress: Kazakhstan significantly outperforms its peers (rising from 72nd to 65th in the past decade [2]); Uzbekistan and Turkmenistan lag. Much of the variation is due to political indicators (women's representation in governance and the economy). In education, near-parity exists almost everywhere, except for certain tertiary indicators in Tajikistan.

ITU ICT Development Index and the UN E-Government Development Index: Kazakhstan also leads here, ranked 28th globally in the 2022 e-Government Development Index [2]. Kyrgyzstan and Uzbekistan are mid-range (80-100th), while Tajikistan and Turkmenistan occupy low positions (130s). These indices, however, do not disaggregate by gender.

GSMA Mobile Gender Gap Report (2023): Europe and Central Asia are noted as having one of the world's smallest gender gaps in mobile connectivity only 1-2% (nearly full equality), with some exceptions. Kazakhstan and Kyrgyzstan likely fall into this low-gap category, while Tajikistan performs worse.

Summary of the Comparison

Kazakhstan performs relatively well across most parameters (high internet access, minimal gender gap in education, strong legal frameworks). Kyrgyzstan, despite modest resources, has ensured broad access and is close to Kazakhstan in women's participation, though deep-rooted challenges (early marriages, rural poverty) persist. Uzbekistan is improving rapidly but began from a more traditional baseline, leaving it behind in women's STEM participation and digital skills. Tajikistan remains the most problematic: weak digitalization combined with restrictive traditions severely limit women's opportunities. Turkmenistan is unique: it combines near-100% literacy with near-0% openness formally universal education, but very limited digital opportunities. Its isolationist policies mean international digital agendas are minimally implemented.

This comparative overview confirms that there are no «one-size-fits-all» solutions for Central Asia. Policies must take into account each country's distinct level and context. At the same time, common directions of action can be identified that are relevant for the entire region. These are presented in the recommendations.

Recommendations

Given the identified challenges, a comprehensive set of measures is proposed for Central Asian countries to overcome barriers and accelerate the implementation of international commitments in digital education and gender equality. These recommendations target governments, educational institutions, international organizations, and civil society.

Expand digital infrastructure and access. Without a strong technical foundation, other measures are ineffective. States should increase investment in internet infrastructure in rural and remote areas, ensuring affordable broadband for all schools and communities. Steps include subsidized fiber-optic connections for schools, satellite internet in mountain villages, and low-cost or free internet packages for disadvantaged students. Community access centers (libraries, cultural houses) can provide girls with safe digital learning spaces. Kazakhstan's rural IT coworking centers offer a replicable model. Equipment upgrades should be continuous, with minimum annual standards for schools.

Improve digital literacy and skills. Training teachers and students in ICT must be a priority. Teacher preparation programs should include digital literacy, with mentoring for older educators, especially women, who may feel

less confident with technology. Students should acquire practical digital skills from early grades, including coding, information search, and office software. Dedicated STEM programs for girls robotics clubs, hackathons, Technovation competitions should be expanded across the region. Adult women in rural areas also need digital literacy courses (e.g., using smartphones, online services, e-learning platforms for children).

Targeted support for girls and women in education. States should introduce scholarships and grants for girls in IT fields, quotas in technical universities, and mentoring programs. Enforcement of laws protecting girls' right to secondary education, including against early marriage, is critical. Community campaigns and parental engagement should emphasize that digital literacy benefits entire families.

Challenge gender stereotypes and shape public opinion. Revising curricula for gender balance, training teachers on equality, and promoting female role models in ICT are essential. Media should highlight success stories of women in technology. Campaigns encouraging shared domestic responsibilities can help free women's time for study and work.

Institutional reforms and governance. Gender analysis should be mainstreamed into all digitalization projects, with measurable indicators (e.g., the proportion of girls using school internet for learning). Governments should improve gender-disaggregated data collection on ICT access and skills. Multi-sectoral councils involving ministries, IT industry, and women's groups can develop joint strategies. Positive discrimination measures such as quotas in IT programs or requirements for female participation in state digital projects could also be considered.

Flexible learning opportunities. Digitalization enables distance and blended learning, crucial for women balancing education with family duties. States should support online courses, evening classes, and second-chance education for young mothers, while creating mechanisms to certify online-acquired skills.

Safe and inclusive digital environments. Women's full participation requires protection from online violence and harassment. Governments should implement cyberethics in school curricula, create hotlines, and strengthen laws against cyberbullying. Localized digital content in minority languages is also essential to ensure inclusivity.

Regional cooperation and knowledge exchange. Central Asian states should share best practices: Kazakhstan's online schooling, Uzbekistan's IT competitions for girls, Kyrgyzstan's women in digital entrepreneurship, Tajikistan's blended learning via radio, and Turkmenistan's maternal support programs. Regional conferences, supported by UNESCO or UN Women, could lead to a joint strategy on «Digital Education for All Women in Central Asia».

Monitoring and accountability. Governments must report not only nominal achievements but also real outcomes to mechanisms such as CEDAW and the UN Education Forum. Independent monitoring by NGOs and researchers should be encouraged to ensure transparency.

In conclusion, implementing these recommendations requires integrated action at the levels of infrastructure, people, and institutions. With sustained commitment, Central Asian states can ensure that the digital era becomes one of expanded opportunities for women, rather than a new source of inequality.

Conclusion

Digital transformation carries enormous potential for accelerating socio-economic development, but it also risks deepening existing inequalities. For Central Asia where women constitute half of the population and have traditionally enjoyed high levels of basic education it is crucial to ensure that digitalization promotes gender equality rather than undermines it. International frameworks such as the SDGs, the Beijing Platform for Action, and CEDAW clearly emphasize: no woman or girl should be left behind in the digital revolution.

The analysis demonstrates that all five Central Asian states formally recognize this goal and have taken policy steps toward it. Yet the gap between declarations and practice remains wide. Unequal infrastructure, entrenched patriarchal norms, and resource and coordination deficits continue to hinder the full realization of women's rights to education and digital opportunities. Rural women and girls are especially vulnerable, as they face both limited technological access and traditional social pressures.

Each country has its own specific context: Kazakhstan has made notable progress in equal access but still struggles with a «glass ceiling» in STEM; Kyrgyzstan, despite relative openness, is challenged by early marriages and migration; Uzbekistan is modernizing rapidly while overcoming its legacy of closed institutions; Tajikistan is building a digital foundation virtually from scratch; and Turkmenistan, in its isolation, risks falling further behind without decisive reforms. The common denominator is clear: without investing in women and girls, the region's digital future will remain incomplete.

For the international community, Central Asia represents an important test case: here, a relatively strong baseline of female education (a Soviet legacy) intersects with the development challenges typical of emerging economies. Successful closure of the digital gender gap in this region would demonstrate the universality of the SDGs and the Beijing commitments. Yet progress remains uneven, and time is short: with the 2030 SDG deadline approaching, current trends suggest that full gender equality in education and technology access will not be achieved without urgent measures.

Crucially, women's education and digitalization are not separate agendas but mutually reinforcing drivers of development. Educated women enhance national human capital, while digital technologies multiply the benefits of education by providing tools for empowerment, employment, and creativity. Central Asia possesses rich human potential (millions of talented young women) and a growing technical base (expanding telecom and IT sectors). Realizing this potential requires dismantling the barriers identified in this study. Implementing

the global agenda is not merely a matter of prestige but a foundation for sustainable development. Global evidence shows that investment in girls' education yields some of the highest social returns.

The digital era poses a challenge to Central Asia: will the region turn digitalization into a driver of inclusive progress, or will it reinforce divides between urban and rural, men and women? The answer depends on today's choices. This study provides grounds for cautious optimism: the problems are well identified, and the solutions are known. What remains is action from government offices to school classrooms. Global digitalization must not bypass the women of Central Asia; rather, they can become the driving force of the region's digital future if given equal opportunities and freed from barriers. Achieving this would constitute a meaningful contribution by Central Asian states to building a more just and prosperous world, aligned with the spirit of the international agenda.

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ЖАҺАНДЫҚ ЦИФРЛАНДЫРУ ЖӘНЕ ӘЙЕЛДЕРДІҢ БІЛІМІ: ОРТАЛЫҚ АЗИЯДА ХАЛЫҚАРАЛЫҚ КҮН ТӘРТІБІН ЖҮЗЕГЕ АСЫРУДЫҢ ҚИЫНДЫҚТАРЫ

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Аңдатпа. Жаһандық кеңістіктің жедел цифрлануы жағдайында әйелдер мен қыздардың заманауи білім алу мүмкіндіктеріне тең қолжетімділігін қамтамасыз ету мәселесі ерекше маңызға ие болып отыр. Цифрлық технологиялар тек білім алудың құралы ғана емес, сонымен бірге тұлға мен мемлекеттің бәсекеге қабілеттілігін айқындайтын әлеуметтік-экономикалық дамудың шешуші факторы болып табылады. Қазақстан, Қырғызстан, Өзбекстан, Тәжікстан және Түрікменстанды қамтитын Орталық Азия өңірі халықаралық деңгейде білім берудегі гендерлік теңдікке қатысты негізгі құжаттарды ресми түрде қолдайды. Олардың қатарында БҰҰ-ның Тұрақты даму мақсаттары, Бейжің іс-қимыл платформасы және CEDAW конвенциясы бар. Дегенмен, осы міндеттемелерді жүзеге асыру барысында бірқатар кедергілер байқалады.

Мақалада цифрлық білім беру мен әйелдердің құқықтары саласындағы жаһандық күн тәртібін айқындайтын халықаралық құжаттар талданып,

аймақтағы бес мемлекеттің ұлттық стратегиялары мен заңнамалық бастамалары қарастырылады. Зерттеу нәтижелері көрсеткендей, ресми жетістіктерге қарамастан, бірқатар күрделі сын-қатерлер сақталуда: цифрлық инфрақұрылымның жеткіліксіздігі, ауыл мен қала арасындағы алшақтық, қыздардың кәсіби траекториясын шектейтін әлеуметтік-мәдени стереотиптер және халықаралық стандарттарды жүзеге асырудағы институционалдық қиындықтар.

Білім беру саласының цифрлану деңгейіне және әйелдердің цифрлық ресурстарға қолжетімділігіне салыстырмалы талдау жүргізу негізінде ерекше назарды қажет ететін басым бағыттар айқындалды. Мақалада цифрлық гендерлік алшақтықты азайтуға, институционалдық тетіктерді күшейтуге және халықаралық міндеттемелерді тиімді орындауға бағытталған нақты ұсынымдар ұсынылған.

Осылайша, мақала мәселенің қазіргі жағдайын бейнелей отырып, цифрлық дәуірде тең мүмкіндіктерге қол жеткізу үшін инфрақұрылымдық, мәдени және басқарушылық шараларды ұштастыратын кешенді тәсілдің қажеттілігін ерекше атап көрсетеді.

Тірек сөздер: цифрландыру, әйелдер білімі, гендерлік теңдік, Орталық Азия, халықаралық күн тәртібі, сандық бөлу, Тұрақты даму мақсаттары

Қаржыландыру: Мақаладағы зерттеу AP26101553 «Цифрлық трансформация және әйелдердің білімі: Орталық Азиядағы гендерлік басымдықтарға халықаралық саясаттың әсері» атты жоба аясында ҚР Ғылым және жоғары білім министрілігінің гранттық қаржыландыруымен жүзеге асырылды.

ГЛОБАЛЬНАЯ ЦИФРОВИЗАЦИЯ И ЖЕНСКОЕ ОБРАЗОВАНИЕ: ВЫЗОВЫ РЕАЛИЗАЦИИ МЕЖДУНАРОДНОЙ ПОВЕСТКИ В ЦЕНТРАЛЬНОЙ АЗИИ

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Аннотация. В условиях стремительной цифровизации мирового пространства особое значение приобретает вопрос обеспечения равного доступа женщин и девушек к современным образовательным возможностям. Цифровые технологии становятся не только инструментом получения знаний, но и фактором социально-экономического развития, определяющим конкурентоспособность личности и страны. Центральная Азия, включающая Казахстан, Кыргызстан, Узбекистан, Таджикистан и Туркменистан, официально поддерживает ключевые международные

документы в области гендерного равенства и образования, среди которых Цели устойчивого развития ООН, Пекинская платформа действий и Конвенция CEDAW. Вместе с тем, на практике реализация этих обязательств сопровождается многочисленными барьерами.

В статье подробно рассматриваются международные нормативные акты, формирующие глобальную повестку в сфере цифровизации образования и прав женщин, а также анализируются национальные стратегии и законодательные инициативы пяти государств региона. Показано, что наряду с формальными успехами сохраняются серьезные вызовы: недостаточная цифровая инфраструктура, региональные диспропорции в доступе к интернету, устойчивые социально-культурные стереотипы, ограничивающие девушек в выборе профессиональных траекторий, а также институциональные трудности внедрения международных стандартов.

На основе сравнительного анализа уровня цифровизации образовательной сферы и степени вовлеченности женщин в цифровые ресурсы выявлены ключевые направления, требующие особого внимания. В работе представлены практические рекомендации по устранению цифрового гендерного разрыва, укреплению институциональных механизмов и повышению эффективности выполнения международных обязательств.

Таким образом, статья отражает современное состояние проблемы и подчеркивает необходимость комплексного подхода, сочетающего инфраструктурные, культурные и управленческие меры для того, чтобы цифровая эпоха стала временем равных возможностей для всех.

Ключевые слова: цифровизация, образование женщин, гендерное равенство, Центральная Азия, международная повестка дня, цифровой разрыв, Цели устойчивого развития (ЦУР)

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