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Digital Literacy and the Gender Wage Gap in Kazakhstan: Evidence from 2021–2025

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Abstract

The article examines the potential of digital skills to reduce the gender income gap in Kazakhstan. The study aims to analyze the relationship between changes in digital literacy and the gender wage gap in Kazakhstan during 2021–2025 by comparing trends in monthly and hourly wages with indicators of digital inclusion among the population. The methodology includes comparative analysis, calculations of monthly and hourly wage gaps, regional comparisons, and correlation analysis. The results show that digital literacy among individuals aged 6–74 increased from 87.30% to 91.13%, while the monthly gender wage gap widened from 21.72% to 28.18%. In 2025, internet usage among men and women aged 16–74 was identical at 95.62%, yet women's wages represented only 71.82% of men's earnings. The hourly wage gap reached 22.41%. These findings indicate that equal digital access does not guarantee income equality. The study distinguishes basic digital literacy, professional digital competencies, and opportunities to apply these skills in paid employment. A conceptual model linking digital access, skill development, employment opportunities, and income growth is proposed. Regional differences further underscore the need to consider local labor market conditions, occupational structures, and access to suitable jobs when designing targeted interventions. The findings highlight the importance of practice-oriented training, employment support, and income-based evaluation of digital inclusion programs. However, aggregate data do not establish causal relationships between digital skills and gender wage inequality.

Keywords: Digital Literacy, Gender Wage Gap, Digital Inclusion, Wage Inequality, Gender Equality, Labor Market, Digital Divide, Economic Inequality

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1. INTRODUCTION

Digitalization is changing the content of work and the ways people gain access to employment. Working with spreadsheets, information systems, digital sales channels, and data analysis tools is becoming a professional requirement across industries. For women, acquiring these competencies can expand job opportunities, increase productivity, and make it easier to return to paid work after breaks. However, increased digital engagement alone does not guarantee reduced gender income disparities: what matters is which skills are used, in which tasks, and how they are paid.

The problem is particularly relevant for Kazakhstan, where the spread of digital services is combined with a persistent wage gap. According to official data for 2025, the average monthly wage for men was 518,259 tenge, and for women, 372,232 tenge. At the same time, a household survey shows that the share of internet users among men and women aged 16–74 is the same - 95.62% (Bureau of National Statistics, 2025). This combination requires moving from the question of access to technology to examining the conditions for obtaining economic returns from its use.

Despite the growing body of international research on digital skills, technological transformation, and gender wage inequality, a key gap remains in understanding how improvements in basic digital literacy relate to changes in gender wage disparities in Kazakhstan. Existing studies have examined human capital, occupational segregation, educational mismatch, and the economic implications of digitalization. However, these dimensions are often considered separately, while the distinction between access to digital technologies, the acquisition of professionally relevant competencies, and their economic returns receives insufficient attention in the national context. Moreover, expanding digital literacy does not necessarily mean greater participation of women in highly remunerated occupations or a corresponding reduction in wage disparities. This creates a need for an integrated assessment of digital inclusion and gender wage dynamics that explicitly distinguish observed statistical relationships from potential mechanisms of economic returns.

The study aims to analyze the relationship between changes in digital literacy and the gender wage gap in Kazakhstan during 2021–2025 by comparing trends in monthly and hourly wages with indicators of digital inclusion among the population. Specifically, we investigate changes in monthly and hourly wage disparities, compare national indicators of digital access and literacy, identify regional differences in digital inclusion, and examine variations in remuneration across economic sectors. We also assess how far aggregate indicators can inform the discussion of gender wage inequality without being interpreted as evidence of individual-level causal effects. Our analysis focuses on two research questions: first, whether increasing digital literacy has coincided with greater gender wage equality; and second, whether similar levels of basic digital access among men and women are sufficient to indicate comparable economic outcomes.

The scientific novelty of our study lies in integrating an examination of digital literacy and gender wage disparities using recent official statistics for Kazakhstan, along with a conceptual distinction between basic digital inclusion and the economically productive application of digital competencies. Rather than treating digital literacy as a direct indicator of labor market competitiveness, we distinguish three interconnected stages: acquiring digital competencies, accessing occupational tasks that require them, and the remuneration associated with their application. This approach provides a framework for interpreting why improvements in digital inclusion may coexist with persistent or widening gender wage disparities.

Our contribution to the literature is threefold. First, we provide descriptive evidence on the joint dynamics of digital literacy and monthly and hourly gender wage gaps in Kazakhstan over 2021–2025. Second, we complement the national analysis with regional indicators of digital literacy and sectoral wage differences,

highlighting the structural conditions that may influence the economic relevance of digital competencies. Third, we propose a conceptual framework and an extended Mincer-type wage specification incorporating the interaction between gender and digital skills to guide future individual-level research. We acknowledge that the available aggregate data do not permit identification of causal effects or direct estimation of the wage returns to digital competencies. Nevertheless, our findings contribute to a more differentiated understanding of the relationship between digital inclusion and gender wage inequality and provide an empirical basis for further investigation of professional digital skills and their labor market outcomes.

2. LITERATURE REVIEW

The study of the impact of digital skills on women's incomes and gender inequality in the labor market is shaped at the intersection of several research areas: human capital theory, the concept of technologically driven demand for skilled labor, the task-based approach to analyzing professions, research on digital inequality, and the modern theory of the gender pay gap. This combination of approaches is fundamentally important, since digital skills alone do not guarantee higher earnings. Their economic return depends on the nature of the work performed, the worker's professional and sectoral position, the intensity of technology use, job quality, and the institutional conditions under which human capital is transformed into income.

The theoretical starting point is Gary S. Becker's concept of human capital. Becker (1964) viewed education, vocational training, and skill acquisition as investments that increase an individual's productivity and potential earnings. Jacob Mincer formalized this logic, proposing that wages depend on years of schooling and accumulated work experience (Mincer, 1974). The Mincer wage function, thus formed, became the basic model for studying the returns on human capital.

However, in the context of the digital economy, the traditional measurement of human capital through education and experience is no longer sufficient. Workers with the same level of education can differ significantly in their proficiency with digital tools, their ability to search for and analyze information, their use of specialized software, their ability to work with data, and their capacity to adapt to technological change. Therefore, it is advisable to consider digital competencies as an independent component of human capital, which can influence productivity even with a fixed formal level of education.

Autor et al. (2003) made a significant contribution to the development of this approach. The authors showed that computerization changes not so much the number of jobs as the structure of the tasks humans perform. Digital technologies can relatively easily replace routine cognitive and manual operations, but they complement non-routine analytical, communicative, and problem-oriented tasks. As a result, technological change increases the value of workers who can solve non-standard tasks and use digital tools not mechanically, but as tools for professional activity.

Deming (2017) builds on this logic, showing that in the modern labor market, the combination of cognitive and social skills is becoming increasingly important. This conclusion is particularly relevant for the digital economy: the technical ability to use a specific program does not necessarily generate a significant wage premium if it is not complemented by analytical thinking, communication, independent decision-making, and the ability to adapt to new technologies. Consequently, digital human capital should be understood more broadly than just basic proficiency in using devices or the Internet.

Falck et al. (2021) present empirical evidence of the economic value of digital competencies. Based on international data on adults' skills, the authors identified a positive return on ICT competencies. A significant part of this return is related to occupational distribution: workers with higher digital skills

are more likely to be found in professions that involve performing abstract and non-routine tasks. Thus, digital competence affects earnings not only directly through increased productivity but also indirectly-through access to higher-paying professional positions.

Chen et al. (2024) found similar results when they investigated the relationship between digital literacy and individual income. The authors develop a multidimensional indicator of digital literacy, which includes information and educational skills, professional use of technology, digital communication, content creation, and security. Their results show that higher digital literacy is associated with higher individual income and may also help reduce intra-group income inequality. This is particularly significant for the present study, as it highlights the need to move from a binary indicator of "possesses/does not possess digital skills" to an analysis of various levels and areas of digital competence.

To define the structure of such competencies, the DigComp 2.2 framework developed by Vuorikari et al. (2022) is applicable. The authors identify five main areas of digital competence: information literacy and data work; communication and collaboration; digital content creation; digital security; and problem-solving. This classification shows that digital literacy is significantly broader than the ability to use a computer, smartphone, or electronic public services. In the context of Kazakhstan, this distinction has fundamental methodological significance. The national statistical indicator of digital literacy captures a fairly broad range of basic ICT skills among the population. However, it cannot automatically be considered an indicator of professional digital competence. For wage analysis, it is important not only to have the skill, but also to consider its complexity, practical application, and ability to create additional economic value.

Studies by Arynova et al. (2025) confirm the relevance of this issue for Kazakhstan. The authors examine the mismatch between the education system and the demands of a digitally transforming labor market and identify persistent gaps between educational outcomes and employers' needs, particularly in ICT and hybrid digital competencies. This means a formal increase in educational level is not always accompanied by the development of the skills that command a monetary premium in the labor market. Sarybayev et al. (2026) examine how gender considerations are integrated into digital education and national digital transformation strategies in Central Asia.

The shift from general human capital to a gender dimension requires accounting for the fact that men and women may derive different returns from the same education and the same competencies. Blau and Kahn (2017), having summarized a significant body of research on the gender wage gap, showed that as the educational characteristics of men and women become more similar, the significance of traditional differences in human capital decreases. At the same time, the substantial role of occupational and sectoral segregation, working hours, family responsibilities, employment interruptions, and other institutional characteristics remains.

Goldin (2014) complements this conclusion with an analysis of labor organization. According to her assessment, a significant part of the persistent gap is linked to non-linear pay for long working hours, employees' strict temporal availability, and career continuity. Some high-paying professions disproportionately reward workers who can be at the workplace or available to the employer at specific times. Since unpaid family responsibilities are distributed unevenly between men and women, this type of work organization can maintain wage differences even with comparable education. Zhang et al. (2023) examine the relationship between digital economic development and gender-based wage discrimination, with particular attention to working hours.

Digitalization potentially changes this mechanism. Remote work, electronic platforms, process automation, and digital communications can make employment more flexible and reduce the importance of a worker's physical presence. However, the positive gender effect is not automatic. If women remain

underrepresented in high-paying digital professions, management positions, and STEM employment, technological development may increase the economy's average productivity without eliminating gender wage gaps.

That is why modern research is increasingly examining not just the digital divide, but several successive levels of digital inequality. Picatoste et al. (2023) highlight the differences in access, use, and the outcomes of digitalization. Their study of European countries shows that relatively high physical access to technology does not preclude persistent gender differences in how digital tools are used and in the resulting economic outcomes. Ma (2022) examines the relationship between internet use and the gender wage gap, providing additional evidence that digital participation may be associated with differences in labor market remuneration.

Wang et al. (2024) investigate heterogeneity in the relationship between digital economic development and the gender wage gap, highlighting differences in how population groups benefit from technological transformation. At the intercountry level, Yin et al. (2023) analyze G20 countries and find a link between digitalization and a reduced gender gap in labor force participation. The strength of the effect depends on the level of economic development: the results for high-income countries differ from those for middle-income economies. This warns against mechanically applying conclusions drawn from developed countries to Kazakhstan. Zhang et al. (2024) examine whether digital economic development helps narrow the gender wage gap in China.

Of particular importance for this study are works that measure the digital skills of specific workers, rather than the overall level of digitalization of the economy. Sami (2026), using data from the Egyptian Labor Market Panel Survey, shows that digital skills are positively related to both wages and the probability of employment. At the same time, the estimated wage premium associated with digital skills is approximately one and a half times higher for women than for men. Channels include a higher likelihood of formal employment and expanded access to highly skilled professions. These results are particularly valuable for the analysis of a developing economy characterized by pronounced occupational segregation.

The latest study by Qu and Xie (2026) also confirms the positive relationship between digital literacy and women's wages. Using data from the China Family Panel Studies, the authors identify not only a direct return on investment but also several channels of impact: expanded information opportunities, changes in working-hour flexibility, and increased women's ability to take advantage of new economic opportunities. The heterogeneity they identify is particularly important: returns differ by education, family situation, and the level of digital literacy itself.

Thus, international studies do not confirm the simple universal formula "increased digitalization — automatic reduction of the gender gap." A conditional relationship appears to be more justified. Digital skills can increase women's income, but the outcome depends on whether they are used professionally, whether they enable a transition to higher-quality employment, whether they are accompanied by career advancement, and whether demand exists for the relevant competencies.

The distinction between basic and advanced digital skills is becoming increasingly important. With a high level of mass digital literacy, the variation in simple skills gradually decreases: most workers know how to use a smartphone, email, search engines, or standard digital services. Under such conditions, the main wage premium may shift towards more complex skills — data analysis, use of professional information systems, programming, work with cloud services, process automation, and the use of artificial intelligence tools.

This conclusion is consistent with the development of the task-based approach by Autor et al. (2003): technology increases the value of a skill primarily when it complements a person in performing non-routine work. Consequently, to assess the gender effect, it is fundamentally important to determine not only whether women have digital skills, but also

whether they hold jobs in which the use of such skills is rewarded.

Kazakhstani studies help specify this issue. Serikbayeva and Abdulla (2022), analyzing the mismatch between education and the job held, show income losses associated with educational and professional mismatch. For the study of digital skills, this result is of direct importance: additional training does not necessarily lead to additional wages if the acquired competencies are not in demand in a specific workplace.

Abdulla and Serikbayeva (2024) directly examine gender differences in the labor market outcomes of Kazakhstan's resource-dependent economy. The authors show the significant role of workers' sectoral distribution. Women and men are not equally represented in sectors characterized by different wage levels. Consequently, even an increase in women's digital competencies does not necessarily lead to a rapid reduction in the overall gender gap if sectoral and professional segregation persists.

Tansykbayeva et al. (2026) conducted a study particularly relevant to this research. The authors analyze gender wage inequality in Kazakhstan's digital economy, considering human capital, professional segregation, employment in the digital sector, managerial status, and working hours. The results they obtained show that formally comparable levels of education and experience do not eliminate gender differences, since women are less represented in STEM professions, the digital sector, and managerial employment.

It is precisely the interaction of these mechanisms that makes it possible to explain why the growth in the average digital literacy of the population can occur simultaneously with the persistence or even temporary widening of the gender wage gap. The mass acquisition of basic ICT competencies reduces the first digital barrier, but it does not automatically ensure alignment between professional positions and wage returns.

Thus, the research gap in Kazakhstan lies in the insufficient integration of three levels of analysis: the presence of digital skills, the professional use of these skills, and their monetary returns, while accounting for the employee's gender. Kazakhstani studies provide a fairly detailed description of the gender gap, sectoral segregation, educational disparities, and digitalization processes; however, the direct link between the type of digital competence, how it is used in the workplace, and women's income outcomes has been studied much less.

This suggests that digital skills should be viewed not as an autonomous guarantee of higher women's incomes, but as a resource whose returns depend on the nature of the work and the institutional environment. The study's main assumption is that higher levels of professionally applied digital competencies are positively associated with women's earnings. However, the magnitude of this return varies by industry, profession, the complexity of digital tasks, and opportunities to convert acquired skills into more productive employment.

This approach allows us to move from the formal question of whether "women have digital literacy" to a more economically meaningful question: in which segments of the labor market and under what conditions do digital skills translate into a real reduction in the gender income gap. It is this logic that determines the subsequent empirical part of the study.

3. METHODOLOGY

The study is descriptive and analytical in nature. Four datasets were used: a time series of the population's digital literacy; a survey of household ICT use for 2025; a publication of key labor indicators for 2025, which includes a wage series for 2021–2025; and data on hourly wages for the same years (Bureau of National Statistics, 2025). The ICT survey covered 21,000 households. The units of comparative analysis are the year, the region, and the published population group, not the individual worker.

For dynamic comparison, the literacy rate among the population aged 6–74 was selected, as it is the only measure with a consistent series from 2021 to 2025. To characterize digital access in 2025, groups of men and women aged

16–74 are used. The age groups differ and are not combined into a single sample. Regional indicators are provided for 2023–2025, with the territorial composition being preserved after the formation of new regions.

To measure gender differences in earnings, the monthly and hourly gender wage gaps are calculated using formula (1):

$$G_M = 100\left(1 - \frac{W_f}{W_m}\right); \qquad G_H = 100\left(1 - \frac{H_f}{H_m}\right) \tag{1}$$

where:

G_M - monthly gender wage gap, %;

G_H - hourly gender wage gap, %;

W_f - average monthly wage of female employees, KZT;

W_m - average monthly wage of male employees, KZT;

H_f - average hourly wage of female employees, KZT;

H_m - average hourly wage of male employees, KZT.

The indicators reflect differences in group averages and do not constitute an assessment of unequal pay for equal work. Growth rates are calculated based on unrounded original values; changes in shares and gaps are expressed in percentage points.

Pearson and Spearman correlations are used only as a diagnostic tool for assessing the joint dynamics of national literacy and the monthly gap. Additionally, the correlation of first differences is calculated. Five years of observations are insufficient for a reliable multivariate model, for testing structural mechanisms, and for concluding causality. Statistical significance and forecast estimates based on such data are not provided.

To provide a framework for future individual-level analysis of the relationship between digital skills and gender wage disparities, an extended Mincer-type wage equation incorporating an interaction between gender and digital competencies is proposed in formula (2):

$$\ln(H_i) = \alpha + \beta DS_i + \delta F_i + \theta(F_i \times DS_i) + X_i'\gamma + \varepsilon_i. \tag{2}$$

where:

H_i - hourly wage of individual i;

ln - natural logarithm;

α - constant term;

DS_i - measured level of digital skills of individual i;

F_i - gender indicator equal to 1 for women and 0 for men;

β - coefficient measuring the association between digital skills and log hourly wages among men;

δ - conditional female–male log wage differential when $DS_i = 0$;

θ - interaction coefficient measuring gender differences in the relationship between digital skills and wages;

X_i - vector of control variables, including education, work experience, region, and other characteristics;

γ - vector of coefficients associated with control variables;

ε_i - stochastic error term;

i - individual observation.

To test the mediating role of employment, it is necessary to compare the specifications before and after including industry, occupation, and task content. Controlling for these variables in the original model may eliminate part of the mechanism driving the transition to better-paid work. Even individual regression requires accounting for self-selection: high income may facilitate skill acquisition, and more capable workers are both more likely to be trained and earn more.

Two descriptive assumptions are being tested: whether an automatic convergence of earnings accompanies the increase in mass

literacy, and whether equality of basic digital access is sufficient for equality of pay. The hypothesis about the causal effect of professional competencies remains a task for microdata. The analysis strategy sequentially moves from dynamics to digital access, territorial conditions, the content of actions, and sectoral remuneration.

4. ANALYSIS AND RESULTS

An empirical study of the relationship between digital literacy and gender-based wage differentiation in Kazakhstan is based on a comparative analysis of the dynamics of the population's digital competencies and the pay rates for men and women for the period 2021–2025. In accordance with the developed methodological approach, the main focus is on identifying changes in the gender income gap against the backdrop of the expanding use of digital technologies, as well as assessing the conditions under which the development of digital skills can be accompanied by an improvement in women's economic situation in the labour market.

The initial stage of the study involves comparing two interrelated processes: the increase in the level of digital literacy among the population and the changes in gender differences in wages. The scientific significance of such a comparison is determined by the fact that the spread of information and communication technologies is considered in modern economic literature as one of the factors contributing to increased labor productivity, expanded professional opportunities, and higher incomes for workers. At the same time, the positive economic effect of digital competencies depends not only on their presence but also on the nature of the work functions performed, the professional specialization, and the opportunities to apply the acquired skills in higher-paying employment segments (Falck et al., 2021).

In Kazakhstan, this issue is becoming particularly relevant due to the simultaneous development of digital infrastructure, the expansion of coverage of the population with digital services and the persistence of significant differences in the level of wages of men and women. Increasing overall digital literacy creates prerequisites for increasing women's participation in the digital economy, but it does not guarantee a proportional increase in their labor incomes. In this regard, it is of fundamental importance to distinguish between the availability of digital technologies, the formation of digital competencies and the possibilities of their economic implementation.

To identify the main trends, we conducted a comparative analysis of the level of digital literacy among the population, the average monthly wages of men and women, and the gender gap in monthly and hourly wages. Using two wage indicators allows for a broader understanding of the nature of gender-based income differentiation, since differences in average monthly earnings may be related both to the level of hourly remuneration and to the length of paid working hours. At the same time, indicators of digital literacy and wages are based on various statistical aggregates, so their comparison is aimed at identifying common trends, rather than establishing the causal effect of individual digital skills on income levels.

The results of the comparative analysis are presented in Table 1, reflecting the dynamics of digital literacy of the population of Kazakhstan aged 6-74 years, the average monthly wages of men and women, as well as the gender gap in monthly and hourly wages for 2021-2025.

Table 1. Digital literacy and gender pay gaps in Kazakhstan, 2021–2025

Year	Men, KZT/month	Women, KZT/month	Monthly gender pay gap, %	Hourly gender pay gap, %	Digital literacy, population aged 6–74, %
2021	281,239	220,160	21.72	17.38	87.30
2022	355,072	265,643	25.19	17.54	88.31
2023	418,788	311,217	25.69	19.46	90.21

2024	468,914	344,496	26.53	18.90	91.15
2025	518,259	372,232	28.18	22.41	91.13

Note: compiled by authors

The data in Table 1 indicate a mixed trend in the population's digital literacy and gender wage differentiation in Kazakhstan. Between 2021 and 2025, the level of digital literacy among the population increased from 87.30% to 91.13%, or by 3.83 percentage points. At the same time, the average monthly salary of men increased from 281,239 to 518,259 tenge, while the salary of women increased from 220,160 to 372,232 tenge. At the same time, the growth rate of men's wages (84.28%) exceeded the corresponding figure for women (69.07%), as a result of which the gender gap in average monthly wages widened from 21.72% to 28.18%, or by 6.46 percentage points. A similar trend was observed in hourly wages, where the gender gap increased from 17.38% to 22.41%. The results obtained show that the expansion of the population's basic digital competencies during the period under consideration was not accompanied by a reduction in gender differences in wages. At the same time, the identified discrepancy represents a descriptive statistical pattern and does not allow us to conclude that professional digital skills have no positive impact on women's individual earnings.

Hourly indicators confirm the need to consider pay separately from employment duration. In 2025, men earned 2,637 tenge per hour, while women earned 2,046 tenge per hour. The 22.41% gap is smaller than the monthly one, but it remains significant. The difference between the two gaps cannot be entirely attributed to working hours, as the statistical procedures and the composition of the observations are not identical.

The Pearson diagnostic correlation between literacy and the monthly gap is 0.902; the Spearman rank correlation is 0.900. After switching to first differences, the Pearson coefficient is −0.310. The sign change across the four observed changes indicates the result's sensitivity to overall temporal dynamics. Neither the positive correlation of levels nor the negative correlation of changes identifies the effect of skills. These calculations reject only the description of the period as simultaneous growth in literacy and a steady reduction in the gap.

To clarify the basic access, examine the results of the ICT survey for 2025. Table 2 separates the gender comparison of device and internet usage and the territorial comparison of literacy. The denominators are indicated directly in the rows.

Table 2. Basic digital inclusion in 2025

Indicator and population group	Group 1, %	Group 2, %	Difference, percentage points
Internet use, population aged 16–74; men/women	95.62	95.62	0.00
Use of a computer, tablet, or laptop, population aged 16–74; men/women	88.18	88.19	−0.01
Digital literacy, population aged 6–74; urban/rural	93.66	86.71	6.95

Note: compiled by the authors

National indicators of internet and computer usage are virtually identical for men and women. This indicates a similar level of basic engagement across the two published indicators, but not an equal level of proficiency in analytics, programming, or professional systems. The use of technology, even during the observed period, does not measure the complexity of the tasks performed or the economic outcome.

The difference between urban and rural areas is 6.95 percentage points in literacy rate among the population aged 6–74. This reflects the territorial environment and is not a separate assessment of rural women's skills. To develop targeted programs, it is necessary to consider the intersection of gender, area type, age, and employment. National gender equality in terms of access does not exclude inequality within individual groups.

Large cities and regions with different literacy values are represented; the list serves as a targeted comparison, rather than a representative regional sample for regression. Table 3 shows regional heterogeneity.

Table 3. Digital literacy of the population aged 6-74 years in selected regions

Region	2023, %	2024, %	2025, %
Astana city	96.97	97.12	97.61
Almaty city	95.50	96.94	95.96
Turkistan Region	93.89	93.51	93.43
Aktobe Region	90.01	90.16	92.58
Abai Region	85.49	86.64	90.07
Atyrau Region	86.63	87.29	85.51
Zhetisu Region	87.10	88.74	85.19
North Kazakhstan Region	82.60	82.81	79.62

Note: compiled by the authors

In 2025, the difference between Astana and the North Kazakhstan Region was 17.99 percentage points. However, the dynamics were uneven: some territories improved their indicators, while others declined compared to 2024. Without information about sampling errors, these changes should not be automatically interpreted as statistically significant deteriorations.

For gender policy, regional indicators matter for education conditions and technology adoption. In areas with lower mass literacy rates, accessible practical training may be a priority. In regions with high indicators, diagnostics of more complex skills and employment opportunities are needed. However, based on the overall regional share, it is not possible to classify women in these areas by professional competence.

Further analysis concerns the content of digital activity. Table 4 combines individual indicators of computer-related activities and purposes of internet use, preserving their original statistical blocks.

Table 4. Individual digital activities and purposes of internet use in 2025

Examination unit	Indicator	Value, %
Computer actions	Working in the Word text editor.	61,28
Computer actions	Excel with basic arithmetic formulas.	43,80
Computer actions	Computer program development.	8,49
Purposes of using the internet	Official online courses.	10,61
Purposes of using the internet	Job search or submitting an application.	7,93
Purposes of using the internet	Participation in professional networks.	6,09

Note: compiled by the authors

The data show that the prevalence of different activities varies significantly. However, having experience working in Word does not prove professional proficiency in document management, and the lack of programming skills does not mean digital

incompetence: many professions do not require writing code. Similarly, using online courses reflects educational activity, but not completed training or increased qualifications.

To reduce the gap, policy should assess skills based on the tasks performed. A woman working in accounting may need to process data sets, set up reports, and monitor information quality; an entrepreneur may need sales analytics and digital financial accounting; a service sector specialist may need to work with an industry-specific system. These are the proposed training areas, not a statement about the identified shortages in specific survey groups.

Table 5 shows differences in average earnings, but it does not measure the digital premium or compare men and women within industries.

Table 5. Average monthly nominal wage by specific types of activity in 2025

Type of economic activity	Average monthly wage, KZT	Relative to the economy-wide level, %
Economy as a whole	443,315	100.0
Information and communication	834,522	188.2
Financial and insurance activities	920,985	207.7
Professional, scientific and technical activities	656,257	148.0
Education	322,678	72.8
Human health and social work activities	334,195	75.4

Note: compiled by the authors

The average salary in information and communications was 188.2% of the national average, while in professional, scientific and technical activities it was 148.0%. These differences allow us to hypothesize about the effect of professional mobility. However, the entire sectoral gap cannot be attributed to digital skills: it is also influenced by job composition, qualifications, capital intensity, and working conditions.

The results suggest an analytical sequence: access to technology creates the learning opportunity; acquiring competencies should be accompanied by completing in-demand tasks; and increases in task complexity and value should be reflected in income. A violation of any transition limits the potential result. Thus, training without a suitable job increases the stock of skills but not necessarily earnings; more complex tasks without a pay review raise demands on the worker but may not improve her relative position.

5. DISCUSSION

The results clarify the meaning of "digital skills as a factor in reducing the gap." The focus should not be on any digital activity, but on competencies that increase women's access to paid tasks and provide them with economic returns. At the aggregate level, the initial premise of automatic income convergence is not confirmed: the spread of mass literacy coexists with a widening wage gap. This is consistent with an approach that distinguishes between the development, use, and remuneration of skills.

A key explanation relates to professional realization. If men and women master the same tools but remain in different positions, digital learning can increase the productivity of both groups without changing relative incomes. International studies capture this ambiguity, highlighting differences in digital use at work and access to advanced tasks (Abraham et al., 2025; Whelan et al., 2026). Kazakhstani aggregates do not allow testing this mechanism, but they do show the need to include it in a further research model.

The sectoral channel also requires careful interpretation. The high average pay in the

information and communications sector does not mean that any woman who has acquired digital skills will receive a corresponding income. The transition depends on entry requirements, professional experience, the location of job vacancies, and the hiring process. In addition, digital competencies can increase income in an existing profession without changing the industry. Therefore, practical programs should consider both professional mobility and changes in tasks at the current workplace (Falck et al., 2021; Serikbayeva & Abdulla, 2022). Territorial results suggest a differentiated approach. For rural and peripheral groups, it is important to combine education with access to devices, stable connectivity, and employers. For large cities, the priority may shift towards analytics, digital process management, and career advancement. Participant and module selection should be based on individual diagnostics, rather than the stereotype of a uniform level of training for women. Regional averages serve as a starting point for such diagnostics, not as a replacement for it.

Remote employment deserves special attention. Working outside the office can reduce spatial constraints, but combining paid work with family responsibilities should not be seen as an automatic advantage for women. Access to training, workplace quality, and care arrangements affect professional fulfillment. Studies on gender policy and women's economic opportunities support a comprehensive approach (World Bank, 2026). The current data do not measure the impact of remote work or care responsibilities on earnings in Kazakhstan.

The development of generative AI increases the importance of competencies that enable not only using the tool but also verifying results, detecting errors, and maintaining responsibility for professional decisions. Programs limited to repeating routine operations can quickly become obsolete. An international assessment of task transformation justifies including adaptation and professional judgment in training, but it does not provide a national forecast of employment losses (Gmyrek et al., 2025).

A practical approach should include consistent diagnostics, training, and support to apply skills. At the first stage, it is advisable to test the ability to perform specific tasks rather than relying on self-assessment. At the second level, organize training around work-related cases and provide access to software. On the third level, connect graduates with employers, internships, or changes in tasks within their current organization. For entrepreneurial programs, the final indicators should be profit and income after expenses, not turnover or the number of online sales.

The assessment of effectiveness should not be limited to the number of certificates. It is necessary to record hourly and monthly earnings, paid hours, job stability, and the application of acquired competencies after six and twelve months. These timeframes are proposed for monitoring and are not established standards in this study. The comparison of income before and after the program should be supplemented with a control group, since overall salary growth may create the appearance of training effectiveness.

With a phased launch, you can use the difference in changes between the participants and a comparable group, checking the parallelism of previous trends. If the number of seats is limited and the rules allow for random allocation, an experimental assessment will better separate the program effect from self-selection. Model (2) in observational data will allow checking for unequal conditional returns, but it will not replace such a design. When analyzing total labor income, consider the probability of employment and the earnings of those employed separately; otherwise, excluding non-working women may bias the conclusions.

The main limitations relate to the lack of a unified dataset on skills, gender, tasks, and earnings. General literacy includes age groups outside the labor market; computer-based activities are not a standardized test; industry averages do not describe women separately. The national time series contains five

observations, and the surveys cover different populations. Therefore, the article justifies the conditions and directions of impact, but does not determine the percentage reduction in the gap from a specific course. A more accurate conclusion requires microdata and verification of professional mechanisms.

6. CONCLUSION

Digital skills can help reduce the gender gap in labor income by increasing productivity, expanding available jobs, and shifting workers to more in-demand tasks. However, official statistics from Kazakhstan for 2021–2025 do not confirm the automatic effect of this mechanism: the growth of mass literacy occurred simultaneously with an increase in monthly and hourly pay gaps.

In 2025, similar basic use of the internet and computers between men and women was combined with significantly different earnings. Therefore, policy should assess the depth of professional competencies and the opportunities for their paid application. General digital literacy is necessary as a basic characteristic of inclusion, but it is insufficient as an independent indicator of economic equality.

The model of a sequential transition from access to technologies to skill acquisition, performance of in-demand tasks, and income generation is substantiated. For its practical implementation, training based on professional cases, employment support, access to work-related digital tools, and transparent assessment of work results are needed. Territorial heterogeneity requires targeted diagnostics and different educational trajectories.

The main scientific conclusion is that the impact is conditional: it is important not only to increase women's income after training, but also to improve their relative position given comparable characteristics and opportunities. To test this conclusion, the authors propose an individual model that accounts for the interaction between gender and digital skills. Further research should combine competency testing with observations of earnings, employment, and professional tasks, and evaluate the programs using a well-founded control group.

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