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## **MAPPING THE GENDER DIGITAL DIVIDE: A BIBLIOMETRIC ANALYSIS OF GLOBAL RESEARCH TRENDS (2003–2024)**

This study aims to identify the significant contextual, evolutionary-chronological, and geographical-ly-sectoral scientific landscape of the gender gap in digital skills through a comprehensive bibliometric analysis. The data was collected from the Scopus database using keywords such as gender, gap, digital, and skills. A total of 203 publications were identified. VOSviewer and MS Excel were used to visualize the results and display the material graphically. The study results show that Interest in the digital gender gap began in 2003; 2) the peak of the popularity of the research area occurred in 2023 when researchers published 59 publications; 3) many studies on the gender gap in the era of digitalization relate to social and computer sciences; 4) researchers from Spain and the USA have conducted the most significant studies; 5) The ratio of keywords forms 34 clusters and studies on the impact of the digital gender gap on employment, socio-economic development, and education. In addition, research trends regarding the high citation of publications have been identified. The results obtained are applicable and can guide further research on the digital gender gap.

**Keywords:** gender gap, digitalization, digital skills, inequality, bibliometric analysis.

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## **Гендерлік цифрлық алшақтықты карталау: жаһандық ғылыми трендтерді библиометриялық талдау (2003–2024)**

Бұл зерттеу жан-жақты библиометриялық талдау арқылы цифрлық дағдылардағы гендерлік алшақтықтың маңызды контекстік, эволюциялық-хронологиялық және географиялық-салалық ғылыми ландшафтын анықтауға бағытталған. Деректер gender, gap, digital және skills сияқты кілт сөздерді пайдаланып Scopus дерекқорынан жиналды. Барлығы 203 басылым анықталды. Нәтижелерді визуализациялау және материалды графикалық түрде көрсету үшін VOSviewer және MS Excel қолданылды. Зерттеу нәтижелері цифрлық гендерлік алшақтыққа деген қызығушылық 2003 жылы пайда болғанын көрсетеді; 2) Бұл зерттеу бағытының танымалдығы 2023 жылы зерттеушілер 59 басылым шығарған кезде болды; 3) цифрландыру дәуіріндегі гендерлік алшақтықты қарастыратын көптеген зерттеулер Әлеуметтік және информатика ғылымдарына жатады; 4) Испания мен АҚШ зерттеушілері неғұрлым маңызды зерттеулер жүргізді; 5) түйінді сөздердің арақатынасы 34 кластерді және цифрлық гендерлік алшақтықтың жұмыспен қамтуға, әлеуметтік-экономикалық дамуға және білім беруге әсерін зерттеуді құрайды. Сонымен қатар, жарияланымдардың жоғары дәйексөздеріне қатысты зерттеу тенденциялары анықталды. Алынған нәтижелер цифрлық гендерлік алшақтықты одан әрі зерттеуге бағыт-бағдар бола алады.

**Түйін сөздер:** гендерлік алшақтық, цифрландыру, цифрлық дағдылар, теңсіздік, библиометриялық талдау.

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### Картирование гендерного цифрового разрыва: библиометрический анализ глобальных научных трендов (2003–2024)

Это исследование направлено на выявление существенного контекстуального, эволюционно-хронологического и географически-отраслевого научного ландшафта гендерного разрыва в цифровых навыках посредством всестороннего библиометрического анализа. Данные были собраны из базы данных Scopus с использованием таких ключевых слов, как gender, gap, digital и skills. Всего было выявлено 203 публикации. Для визуализации результатов и графического отображения материала использовались VOSviewer и MS Excel. Результаты исследования показывают, что интерес к цифровому гендерному разрыву возник в 2003 году; 2) пик популярности этого направления исследований пришелся на 2023 год, когда исследователи опубликовали 59 публикаций; 3) многие исследования, посвященные гендерному разрыву в эпоху цифровизации, относятся к социальным и компьютерным наукам; 4) исследователями из Испании и США были проведены наиболее значимые исследования; 5) соотношение ключевых слов образует 34 кластера и исследования влияния цифрового гендерного разрыва на занятость, социально-экономическое развитие и образование. Кроме того, были выявлены тенденции исследований, касающиеся высокой цитируемости публикаций. Полученные результаты применимы и могут служить руководством для дальнейших исследований цифрового гендерного разрыва.

**Ключевые слова:** гендерный разрыв, цифровизация, цифровые навыки, неравенство, библиометрический анализ.

## Introduction

The world's countries are transitioning to new areas of the industrial revolution, where digitalization occupies a special place in development. Digitalization affects all areas of the economy, including gender economics. From a gender perspective, according to the UN Sustainable Development Goals, there is gender inequality in the world, where there may be a gender imbalance in access to resources, academic advancement, access to education, as well as a gender wage imbalance and digital inequality. The gender economy is a part of the economy where women's rights and opportunities are considered, and digitalization can widen the gap in this direction. On the one hand, digitalization can empower women in the labor market, in business, in access to education, and in conducting research; on the other hand, it can widen the gap in obtaining digital skills. Thus, digitalization is one of the main factors in changing economic trends, including the labor market. As developed countries show, the labor market is transforming. In this case, some professions that were relevant a century ago can be replaced by digital tools, artificial intelligence, and robots. According to UN research, women in many countries are 25% less likely to use ICT to solve basic tasks such as working on computers and other office equipment

(UNESCO, 2017). At the same time, men are four times more likely to use digital programming skills (UNESCO, 2019). In the G20 countries, 7% of ICT inventions belong to women, while the global average is 2% (Mariscal et al., 2019). Thus, we can see a trend of gender imbalance in the use of digital skills in the workplace. According to recruitment experts for Silicon Valley technology companies, the number of candidates for technical positions in artificial intelligence (AI) and data science is often less than 1% of women (Shah & Warwick, 2016). To highlight the difference, 2.5 million women with college degrees worked in STEM in 2009, compared with 6.7 million men. The total workforce was 49% female and 51% male at that time, highlighting the apparent gap (Raghuvanshi & Mishra, 2023). Consequently, the gender gap in digital skills often manifests itself in countries with poverty and low levels of education. In addition, age affects the acquisition of skills necessary to work with digital technologies.

As you know, young people learn new skills faster than the elderly. In addition, the reasons for the gender gap in digital skills may be Internet accessibility, income level, social stereotypes, and others (Yang & Du, 2020). In this context, we should consider Jan van Dijk's Multilevel model of digital inequality. Dijk distinguishes four stages of digital inequality, which include motivational access,

physical access, skills access, and actual use. In this context, an example can be given if a woman in rural areas has a smartphone (physical access), but is not confident in herself and is afraid to break the technique (motivation), does not know how to search for information (skills) and uses the phone only for WhatsApp (limited use) – this is digital inequality. Van Dijk emphasized that digital inequality is a consequence of social inequality, which naturally encompasses factors such as gender, age, education, and income. In addition to this theory, there is another theory by Amartya Sen, which focuses on human-centricity, specifically digital inequality as a factor in overcoming gender inequality. This theory suggests that it enables a person to live a life that they consider valuable. The essence of the Hay model is not to ask “How many resources do you have?” and ask, “What can you do with them?” (Mormina, 2018).

This study aims to identify the significant contextual, evolutionary-chronological, and geographically-sectoral scientific landscape of the gender gap in digital skills through a comprehensive bibliometric analysis. This approach helps to identify the main scientific trends, identify the most cited works and authors on the gender gap in digital skills, and assess the geographical distribution of research and the dynamics of its development. Based on this, this study will test the following hypotheses:

H1: There is a growing interest in the gender gap in digital skills in scientific databases.

H2: Research on this topic is concentrated mainly in countries with a high level of digitalization and a developed higher education system.

Thus, the structure of this article includes the following sections: a literature review, which provides an overview of previous research and opinions of authors who have studied this problem. The Methodology section describes an algorithm for identifying the results. The Results and Discussion section contains data on the chronological dynamics of publications, the level of interest in various scientific fields and countries, and identified scientific trends in the study of the gender gap in digital skills. In conclusion, the study's main results are summarized, and conclusions are formulated.

## Literature review

One of the key factors contributing to the emergence of the gender gap in digital skills is social inequality, manifested through cultural and gender stereotypes. When a man and a woman do not have

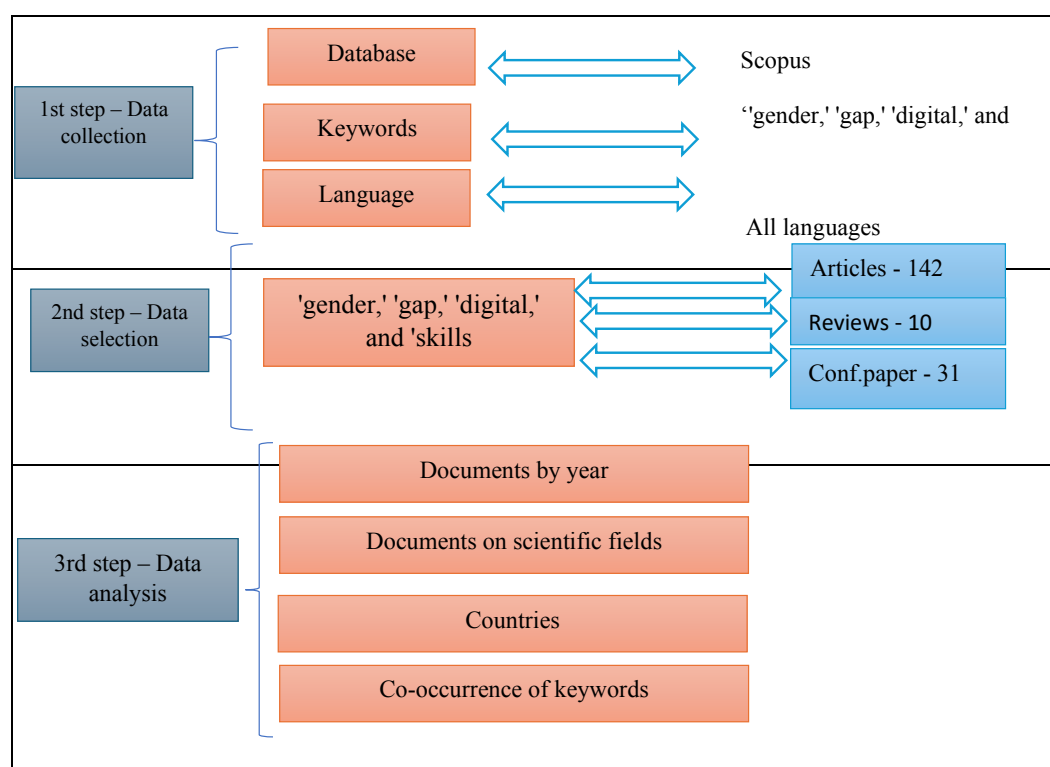
equal conditions and interest in obtaining digital skills. Thus, the root of the digital gender gap is the socio-economic situation in the country. Favorable conditions, developed and accessible infrastructure, and a modern education system contribute to bridging the gender gap in digital skills. At the same time, research also shows that in several countries, women face fewer opportunities to master technology due to traditional roles that assign them limited social functions. These barriers are reinforced by economic difficulties that reduce women's access to education and technological resources (Mahdi et al., 2023). Education systems are key in reducing the gender gap in digital skills. Digital literacy is also linked to the availability of technology and learning resources. One way to overcome digital equality is to talk about STEM (science, technology, engineering, and mathematics) programs, where more attention is paid to the female sex and its development in the fields of science, technology, engineering, and mathematics (George-Reyes et al., 2024). As practice shows, the spread of digitalization in different regions is different; therefore, the spread of digital skills is different. Therefore, when different regions come into contact, there is a difference in digital skills, which suggests that the education system is distributed in different ways, both in regions and by gender. International organizations and governments from different countries are taking steps to close the gender gap in digital skills. For example, UN initiatives such as Digital Skills for All aim to create training programs for women and girls in developing countries (Chernenko & Zemzyulina, 2024). In addition, economic measures, including grants and subsidies for education, improve women's digital literacy. There are also social programs where educational centers conduct free online courses that teach basic digital skills. A literature review shows that the gender gap in digital skills is a multifaceted issue that requires an integrated approach. To solve this, combining education, economics, and technology efforts is necessary.

## Methodology

The research methodology includes bibliometric analysis. Bibliometric analysis is a method of analyzing large amounts of data that allows you to study the evolution of a subject and identify trends in scientific research and related fields. The tools used for data analysis in this article are the Scopus analysis tool and VOSviewer v.1.6.19, which allows the creation and analysis of bibliometric maps

(Brück, 2023; Santos, 2023). VOSviewer provides the ability to create visualization maps based on keywords and can also use keywords to link countries, authors, and citations (van Eck & Waltman, 2010; Pilkina & Lovakov, 2022). Similar studies were conducted by other scientists who identified research areas by analyzing keywords from the databases Scopus, Pubmed, VOS, and Lens databases and using the software VOSviewer, MS Excel, Bibliometrix, SpaceMap, etc. (Kataeva et al., 2023; Adalı et al., 2024; Sánchez-Jiménez et al., 2024; Owusu, 2024; Coronel-Pangol et al., 2024). This study uses the Scopus database. The keywords are 'gender,' 'gap,' 'digital,' and 'skills.' By this re-

quest, 295 publications were identified. According to the analysis for the period 2003-2024, 242 publications were found. A language filter was then applied, with English as the chosen language, as the goal was to identify global scientific trends. For this purpose, publications in highly rated journals accepting articles only in English were selected. Out of 242 publications, only articles, reviews, and conference proceedings were selected, resulting in 183 publications included in the analysis. Graphs and diagrams are based on, where the popularity of keywords is analyzed by the number of publications for 2003-2024, by industry, country, organizations, and authors (fig.1).



**Figure 1** – Stages of bibliometric analysis

Note – compiled by the authors

The visualization method is performed in the VOSviewer program, which examines publication trends on the topic under study by keywords and by country.

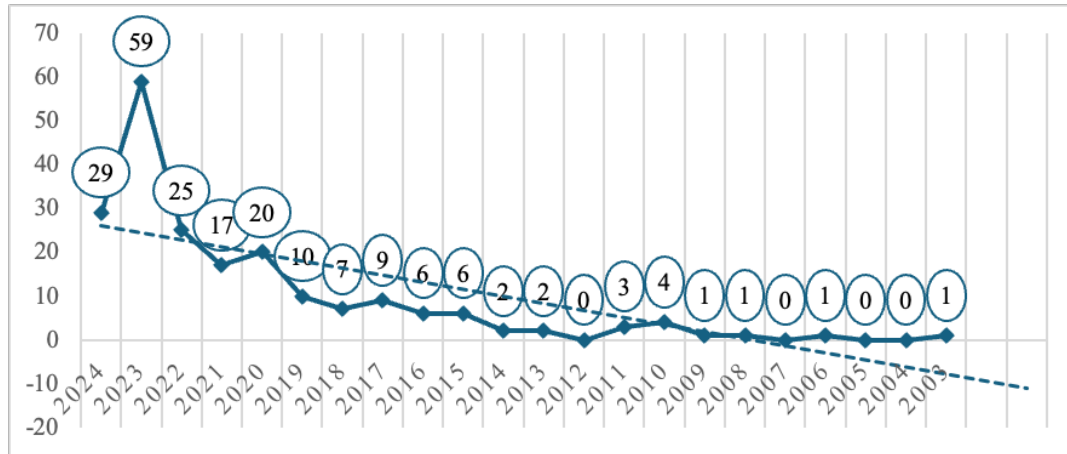
## Results and discussion

The gender gap in digital skills is a relatively new wave of research. Mastering digital skills is a requirement for modern trends in developing coun-

tries worldwide. According to Figure 2, on the issue of the digital gender gap, the first studies in the Scopus database were conducted in 2003, where the authors predicted an increase in the gap in digital skills between different categories of the population (Dijk & Hacker, 2003). From 2003 to 2009, the research topic proceeded to bear stronger. During the selected period, the researchers published publications in which the authors describe the digital gender gap in rural areas, in the cultural sphere, and education

(Vandenbroeck et al., 2007). From 2009 to 2014, the popularity of the topic of the digital gender gap was moderate; 11 publications were published during the selected period. Since 2014, there has been

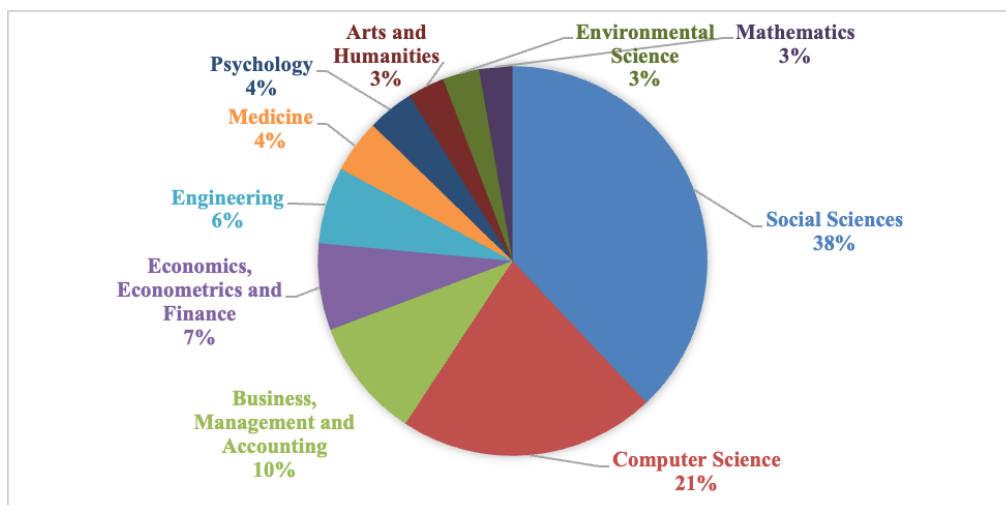
a steady trend towards an increase in the number of publications on the topic under study. The peak of popularity of the topic of the digital gender gap was in 2023 when researchers published 59 publications.



**Figure 2** – The dynamic of publications  
Note – compiled by the authors based on the Scopus database

The data in Figure 3 shows the popularity of digital gender inequality in the context of science. Gender inequality is a social problem because it is the fifth goal of sustainable development and characterizes the rights and opportunities of women in society. Consequently, research on the digital gender gap is mainly conducted in the field of social sciences, which accounts for 137 publications, followed by computer science – 77 publications. The

impact of digital gender development on social and economic life is significant, as digital skills can bring additional income to the owner or increase income levels, thereby changing the quality of life. Thus, the following popular fields of science for research on the digital gender gap are Business, Management, and Accounting (36 publications), Economics, Econometrics, and Finance (26 publications), Engineering (23 publications), and others.



**Figure 3** – The subject structure of scientific publications on the digital gender gap  
Note – compiled by the authors based on the Scopus database





During the keyword research, 34 clusters were formed. They help to identify, visualize, and understand the most common keywords related to the field of study. The main ones are presented in Table 1. The first block consists of 65 keywords, which include research in the following areas: Digital inequality, digital divide, digital competencies, gender inequality, and the Internet. This section is devoted to a study that highlights the existence of an imbalance in digital skills, as the era of digitalization requires appropriate competencies that necessitate the use of digital skills. Accordingly, many international organizations (UN-Global Digital Compact, UNESCO – “ICT in Education Strategy”) and associations (EU – Digital Compass 2030, Digital Transformation Strategy for Africa (2020–2030)) are adapting modern education and infrastructure in the labor market to the use of digital skills. Thus, the modern labor market requires skills and competencies that can be used in the digital economy. The second block consists of 64 keywords that are devoted to research and raise issues related to the formation of digital skills and the accessibility of digital learning. This section highlights that many developed countries have already transformed their educational systems to teach digital competencies and invested in educational infrastructure that will create conditions for training personnel with digital competencies and skills. The third block consists of 61 points: women’s employment, digital inequality in the centers, territorial digital inequality and, the wage gap. The research areas of this cluster are related to the digital gender gap, which can contribute to the gender imbalance in income generation, varying by territory. For example, in developed countries, the incomes of women with digital skills are higher than in developing countries. In addition, it is worth noting that there is an imbalance in the distribution of digital skills in developing countries. While women in the developed regions of the state possess digital skills, in rural areas of the country, they may not have access to digital devices or the Internet. Thus, an imbalance in digital skills can significantly affect the social life of women in the territorial division. The fourth block includes the fol-

lowing keywords: learning strategy, software skills, technology education, infrastructure, digital learning, as well as primary, and secondary schools. This field includes research to acquire digital skills that will evolve. Namely, according to the level of development of digital technologies, human capital must acquire the appropriate skills since digital skills are soft skills that complement basic education. For example, advanced digital gadgets should be provided in digital classrooms, educational institutions should provide high-speed Internet access for public use, etc. The following fifth block characterizes the relationship between the digital gender gap and the state’s socio-economic development. The Cluster 5 research trend also highlights the importance of public policy. It focuses on overcoming digital inequality based on gender, territory, and social status, which can positively affect the economy’s competitiveness. Thus, bridging the digital gender gap can boost women’s economic activity, thereby increasing not only the competitiveness of the economy but also improving the well-being of the population.

Next, let us look at research trends in highly cited publications. Seven articles with more than 100 citations were selected from the 203 publications analyzed. Information about the articles is presented in Table 2. The most cited publication is J. Van Dijk, K. Hacker– 938 citations. The authors show the influence of age and gender on the level of digital skills (Dijk, 2006). The article by E.J. Helsper and R. Eynon – 652 quotes shows that time does not stop and a lot of digital technologies are being created, so some part of the population does not have time to master digital gadgets for use (Helsper & Eynon, 2010). The article examines the generational gap in digital skills acquisition and mentions the term digital aboriginal. The third article, which contains 166 citations, is devoted to the gender digital gap among Internet users – university students (Correa, 2010). The following article, by E. Hargittai, A. Shaw, which has a citation index of 153, is devoted to the analysis of users of the Internet resource Wikipedia, where it was found that Wikipedia is most often edited and used by men who are highly qualified to use the Internet (Hargittai & Shaw, 2015).

**Table 1** – Description of the clusters formed by keywords

Cluster	Cluster Color	Keywords	Description
1 (65 items)	Red	Digital divide, digital gap, digital competences, gender divide, internet	The existence of a digital skills gap in the labor market. The impact of Internet accessibility on the digital divide. The existence of a link between gender inequality and the digital divide.
2 (64 items)	Green	Access to information, rural area, knowledge gap	Accessibility and importance of digital knowledge. The impact of digital skills on the search and development of new knowledge
3 (61 items)	Blue	Female employment, gender digital divide, territorial digital divide, wage gap	The impact of the digital divide on workplace accessibility for women. To identify the impact of the digital divide on the wages of men and women.
4 (59 items)	Yellow	Training strategy, soft skills, technology education, infrastructure, learning in digital network, primary and secondary school	The importance of teaching digital skills in primary and secondary schools, with particular attention to gender differences and creating the conditions and appropriate infrastructure to reduce the digital skills gap.
5 (57 items)	Purple	Economic and social effect, quality of life, social policy	The negative impact of the digital gender gap on socio-economic development within the country.

Note – compiled by the authors based on Figure 5

**Table 2** – The 7 most cited studies in the research area in the period from 2003 to 2024

	Authors	Title	Source
1	Van Dijk, J., Hacker, K.	The Digital Divide as a Complex and Dynamic Phenomenon	Information Society
2	Helsper, E.J., Eynon, R.	Digital natives: Where is the evidence?	British Educational Research Journal
3	Correa, T.	The Participation Divide Among Online Experts: Experience, Skills and Psychological Factors as Predictors of College Students' Web Content Creation	Journal of Computer-Mediated Communication
4	Hargittai, E., Shaw, A.	Mind the skills gap: the role of Internet know-how and gender in differentiated contributions to Wikipedia	Information Communication and Society
5	Vicente, M.R., Novo, A.	An empirical analysis of e-participation. The role of social networks and e-government over citizens' online engagement	Government Information Quarterly
6	Siddiq, F., Gochyyev, P., Wilson, M.	Learning in Digital Networks – ICT literacy: A novel assessment of students' 21st century skills	Computers and Education
7	van Deursen, A.J.A.M., van Dijk, J.A.G.M.	Internet skill levels increase, but gaps widen: a longitudinal cross-sectional analysis (2010–2013) among the Dutch population	Information Communication and Society

Note – compiled by the authors based on the Scopus database

Many states use digital technologies to serve the population remotely. In this context, the publication of Vicente M.R., Novo A., which has been indexed 138 times, reveals the population's opinion regarding the using of digital technologies to communicate with the state (Vicente & Novo, 2014). It was difficult for many people to master the digital state,

but this option has several advantages. The authors F. Siddiq, P. Gochyyev, and M. Wilson, who have 109 citations, refute the existence of digital gender differences among secondary school students in developed countries (Siddiq, 2017). The article by van Deursen, van Dijk, cited 108 times, is devoted to public policy in digital literacy, where the authors



advise instilling strategic and operational Internet skills in addition to basic skills (van Deursen & van Dijk, 2015). Thus, the problem of the digital gender gap has many aspects of research that require a deeper study.

## Conclusion

The gender imbalance in digital skills remains an acute problem affecting women's access to opportunities in the economy of the future. According to research, women are, on average, less likely to receive education in the field of STEM (science, technology, engineering, mathematics), which limits their participation in digital transformation. In addition, the gap in access to technology and stereotypes about "male" and "female" professions contribute to the low representation of women in the IT sector, programming, and cybersecurity. This imbalance has long-term consequences for both the economy and the social sphere. Insufficient digital literacy among women reduces their competitiveness in the labor market and restricts access to high-paying professions. At the same time, the diversification of the technology industry could lead to more innovative solutions tailored to the needs of different populations. Comprehensive measures are needed to reduce the gender gap in digital skills, including expanding educational programs, supporting women in IT careers, and overcoming established biases.

The impact of digitalization on the gender gap in a woman's life has attracted the attention of many researchers. Two key hypotheses were put forward in the framework of the study. The analysis results confirmed the first hypothesis: the popularity of digital skills and their impact on gender inequality began to grow rapidly in 2010 and reached its peak in 2023 when 59 scientific papers were published. At the same time, the first publications on this topic date back to 2003. This dynamic can be explained by the fact that digitalization has begun to occupy an important place in the state's functioning and has penetrated all spheres of society. It is expected that

as the scale of digital transformation increases, the topic of gender digital inequality will remain relevant, as mastering digital skills will become an increasingly difficult task. The second hypothesis has been partially confirmed. According to the results of the analysis, gender inequality in digital skills is more often raised in studies conducted by scientists from developed countries. However, in recent years, researchers from developing countries have increased interest in this topic, indicating the increasing importance of digitalization and the growing involvement of women in digital technologies.

This study has limitations that should be considered when interpreting the results. Namely, in this study, the analysis is based solely on data from the Scopus database, which may limit the completeness of scientific literature coverage, since there are other databases of scientific publications (for example, Web of Science, Lens, PubMed). This may affect the representation of individual regions, languages, or scientific schools. Another limitation may be the choice of only English-language publications, which, on the one hand, allows you to focus on global trends, but, on the other hand, excludes research published in other languages, which will limit the identification of national characteristics. In addition, only articles, reviews, and conference proceedings were considered during the selection process, which limits coverage to other forms of scientific output. Additionally, it is worth noting that the bibliometric approach reflects the quantitative characteristics of scientific activity, which may also limit the conclusions drawn about the gender gap in digital skills.

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