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The Impact of Wi-Fi on the Educational Process and Academic Performance in Ukrainian General Secondary Education Institutions

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About the Study

This research was conducted by a team of analysts at CIVITTA UKRAINE LLC and supported by a client organisation.

This report reflects the views of the authors and does not necessarily represent the position of the key stakeholders cited in the study.

CIVITTA UKRAINE LLC is a leading consulting company providing expert services in socio-economic analysis, project management, and public policy development. The goal of CIVITTA UKRAINE LLC is to identify the systemic causes of social problems and propose potential solutions. Our approach is research-based: we study social processes and public policies, disseminate critical knowledge, promote progressive change, and strengthen the community of supporters of these changes.

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Key project stakeholders

The Ministry of Education and Science of Ukraine, the State Service for Quality Education of Ukraine, the Ukrainian Center for Educational Quality Assessment, the Institute of Educational Analytics, the “Unified School” Information and Communication System, and General Secondary Education Institutions of Kyiv.

List of abbreviations and glossary

AI	Artificial Intelligence. A branch of computer science focuses on developing intelligent machines capable of performing tasks that typically require human intelligence, such as speech or image recognition, problem-solving, and content generation.
CGSE	Complete General Secondary Education - a systematic set of learning outcomes and competencies acquired by an individual at the levels of primary, basic secondary, and specialized secondary education, as defined by relevant state standards.[1]
DIGCOMP	The European Digital Competence Framework for Citizens. A tool for improving citizens' digital competence, first published in 2013.[2]
EEI	An Extracurricular Educational Institution is a component of the extracurricular education system that provides knowledge, develops skills and abilities based on interests, meets the needs of individuals for creative self-realization and intellectual, spiritual, and physical development, and prepares them for active professional and social activities.
EIA	External Independent Evaluation.
GEEAP	The Global Evidence for Education Action Panel. An independent, interdisciplinary group of global providing recommendations on cost-effective approaches to improving learning for low- and middle-income countries.[3]
GSEI	General Secondary Education Institution. A legal entity whose primary activity is providing education at one or more levels of complete general secondary education. (Ukrainian acronym: ЗЗСО).[4]
ICT	Information and Communication Technologies. A set of methods, processes and tools used to create and manage digital education systems, resources, and networks.[5]
IEA	Institute of Educational Analytics. A state scientific institution for the automated collection, verification, and systematic analysis of educational statistics from national information systems. (Ukrainian acronym: ІОА).
MES	Ministry of Education and Science of Ukraine. The main governing body for education in Ukraine.
NMT	National Multi-Subject Test. A standardized test used for university admissions in Ukraine.
NUS	New Ukrainian School. A comprehensive reform of school education in Ukraine.
OECD	The Organization for Economic Cooperation and Development. A forum where 37 democratic countries with market economies collaborate to develop policies promoting sustainable economic growth.
SSQEU	State Service for Quality of Education of Ukraine. The central executive body responsible for implementing state policy on education quality and supervising educational institutions' regarding compliance with legislation. (Ukrainian acronym: ДСЯО).[6]
UCEQA	The Ukrainian Center for Educational Quality Assessment. A state institution that conducts external independent assessment and monitors the quality of education. (Ukrainian acronym: УЦОЯО). [7]
UNESCO	The United Nations Educational, Scientific and Cultural Organization. A specialized agency of the United Nations.
UNICEF	The United Nations Children's Fund. The UN agency responsible for providing humanitarian and development assistance to children worldwide.

[1] Ibid.
[2] European Commission. 2016. DigComp 2.0: A framework for the digital competence of citizens. https://binpo.com.ua/wp-content/uploads/2021/04/DigComp-2.0.pdf
[3] World Bank Group. 2023. The critical importance of an education landscape driven by evidence. "https://www.worldbank.org/en/news/feature/2023/06/21/evidence-based-cost-effective-learning-education-improvements"https://www.worldbank.org/en/news/feature/2023/06/21/evidence-based-cost-effective-learning-education-improvements
[4] Law of Ukraine "On Complete General Secondary Education." https://zakon.rada.gov.ua/laws/show/463-20#Text
[5] Spirin, O. M. Information and communication technologies (ICT) in education // Encyclopedia of Education / National Academy of Pedagogical Sciences of Ukraine: 2nd ed., supplemented and revised. Kyiv: Yurinkom Inter, 2021. Pp. 426-427. https://lib.iitta.gov.ua/id/eprint/730761/1/%D0%86%D0%9A%D0%A2%20%D0%B2%20%D0%BE%D1%81%D0%B2%D1%96%D1%82%D1%96%20%D0%A1%D0%BF%D1%96%D1%80%D1%96%D0%BD%20%D0%95%D0%91.pdf
[6] Resolution of the Cabinet of Ministers of Ukraine "Some Issues of the State Service for Quality Education of Ukraine." https://zakon.rada.gov.ua/laws/show/168-2018-%D0%BF#Text
[7] Ukrainian Center for Educational Quality Assessment. https://testportal.gov.ua/pro-utsoyao

US	Unified School. An information and communication system designed for educational institutions, students, parents, and education management bodies. (Ukrainian acronym: ЄШ).
World Bank	An international financial institution that provides loans and grants to low- and middle-income countries for economic development.

Access to high-speed wireless internet (Wi-Fi) in general secondary education institutions (GSEIs) is globally recognized as a key factor in modernizing the education process. Governments and international organizations are investing in connecting schools to the internet to improve educational quality, prepare young people for the digital economy, and reduce the digital divide.

However, scientific research and analytical data show that Wi-Fi has a mixed impact on education; its effectiveness and effect on academic achievement depend on many factors.

This analysis examines the international experience of school Wi-Fi's impact on student academic performance, the organization of the educational process (efficiency, innovation of methods, individualization), discipline, motivation, and student engagement, as well as the financial and economic aspects of its implementation. The analysis is based on official reports from UNESCO, UNICEF, the OECD, the World Bank, and peer-reviewed scientific publications.

Chapter 1. Research Methodology

The research topic "The Impact of Wi-Fi on the Educational Process and Academic Performance in Ukrainian General Secondary Education Institutions" focused on a detailed analysis of two key areas:

1) **the organization of the educational process and its characteristics (e.g. continuity of learning) in GSEIs using Wi-Fi capabilities**

and

2) **the impact of Wi-Fi networks and digital tools on student academic performance,** including the correlation with the presence or absence of Wi-Fi networks in schools.

The research methodology involved detailed and comprehensive engagement with all participants in the educational process and key stakeholders in the field of education.

Specifically, this included:

- Preparing informational and analytical materials for school administrators, teachers, students, and their parents (legal representatives).
- Conducting online surveys, disaggregated for each category of participant.
- Conducting in-person and online interviews with school administrators and teachers.
- Comparing the results with international and national practices in schools with full, partial, or no Wi-Fi connectivity.
- Formulating questions and conducting interviews with representatives of key stakeholders involved in forming and implementing educational policy, including the processes of management, monitoring, and evaluation of educational activities in GSEIs.

The stages of the research methodology include:

- **International Context.** An analysis of the impact of Internet and Wi-Fi access on the effectiveness of educational processes and student academic performance in other countries.
- **Ukrainian Context.** An analysis of reports based on research, scientific publications, and meta-analyses on the impact of Wi-Fi networks in Ukrainian schools, as presented by key stakeholders such as the Ministry of Education and Science, SSQEU, UCEQA, IEA, and US.
- **Research on the impact of Wi-Fi in Pilot Secondary Schools.** A sample of secondary schools in Kyiv was selected based on statistical data on Wi-Fi availability and the project team's criteria. The research involved online surveys (using Google Forms) and in-depth interviews with GSEI administrators and teachers. The study also included a regulatory analysis of educational programs and a comparative analysis of how modern Ukrainian teachers prepare for and design lessons.

Stakeholders were involved by sending formal requests for information relevant to the research topic and by holding online and in-person meetings.

Chapter 2. International Context

2.1. Student Academic Performance

The digital transformation of education is essential for improving its quality, accessibility, and effectiveness. Integrating ICT into the educational process allows for personalized learning paths, increased student engagement, and enhanced digital skills. International experience shows that providing internet connectivity in educational institutions can positively impact academic outcomes, but these benefits are only realized through the effective use of technology.

A large-scale study based on long-term data (2000-2014) from over 9,000 public schools in Texas, USA, covered 1,243 school districts. It included an analysis of 15,000 observations on internet access costs, over 115,000 academic performance indicators, 106,000 cases of disciplinary problems, and regional socio-economic characteristics. Data on internet access funding was obtained from the Universal Service Administrative Company (USAC), while academic and disciplinary indicators came from the Texas Education Agency (TEA) and the Public Education Information Management System (PEIMS), respectively.[8,9] The researchers found that increased school district spending on internet access (SDIAS) contributed to a statistically significant improvement in eight of the eleven key indicators of academic performance (Figure 1). This included higher high school graduation rates, more students achieving passing scores on college entrance exams (SAT/ACT), more graduates successfully completing advanced courses, and improvements in standardized test scores in mathematics, reading, writing, and social studies. The effect was particularly pronounced in regions with higher levels of home internet access.

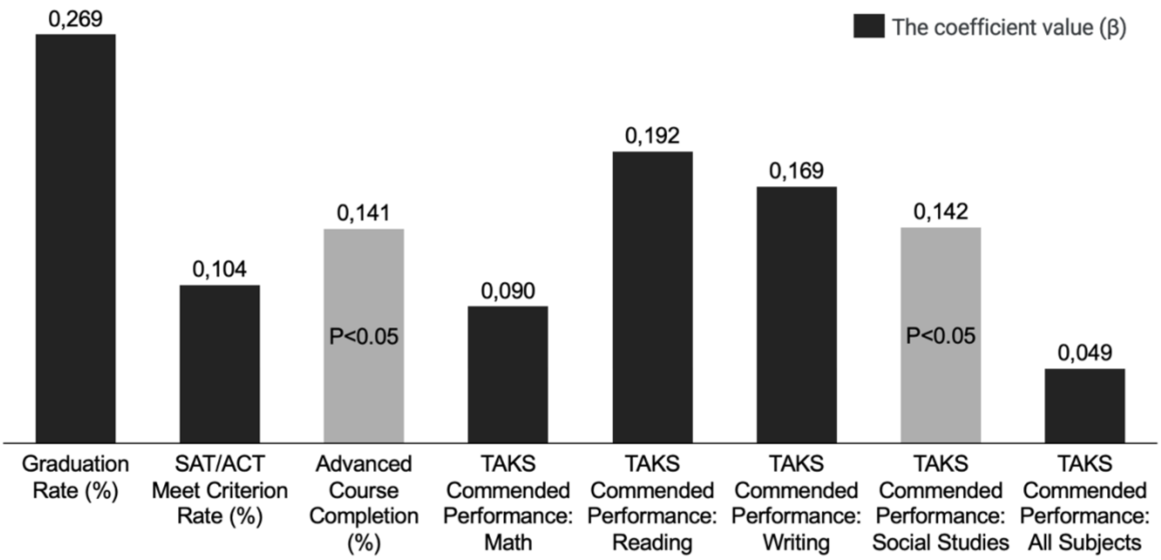

Figure 1. Regression coefficients for the impact of increased internet spending (SDIAS) on academic outcomes. Chen, Mittal, Sridhar (2021)

At the same time, increased internet spending was also associated with higher levels of disciplinary problems, particularly Part II offenses, which require additional monitoring and

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[8] Chen, Y., Mittal, V., & Sridhar, S. (Hari). 2020. Investigating the Academic Performance and Disciplinary Consequences of School District Internet Access Spending. Journal of Marketing Research . https://doi.org/10.1177/0022243720964130

9 Rice University. 2021. Internet-access spending improves academic outcomes, study of Texas schools finds. https://news.rice.edu/news/2021/internet-access-spending-improves-academic-outcomes-study-texas-schools-finds#:~:text=improvement%20in%20commended%20performance%20in,the%20number%20of%20broadband%20providers

behavior management measures. An economic assessment showed that investing in internet access brings significant economic benefits to schools: a $600,000 increase in annual internet access spending results in an increase in future student earnings ranging from approximately $820,000 to $1.8 million per district, while losses due to disciplinary problems are estimated at $25,800 - $53,400.

These positive changes were particularly pronounced in areas where students had greater access to the internet outside of school.[10] Thus, providing Wi-Fi access, combined with adequate digital literacy among students, can significantly improve traditional academic outcomes.

In an OECD pilot project in Germany, students who regularly used digital devices while studying mathematics, science, and languages demonstrated better problem-solving skills and 15% higher scores on the new PISA digital assessment test modules.[11] For example, digital tools helped students develop computational thinking and self-regulated learning skills that are difficult to cultivate through traditional means.[12] This shows that, when implemented properly, technology can significantly improve learning outcomes.

However, other international studies, including those by the OECD (2015, 2022),[13][14] , PISA (2018,[15] 2022[16]) and the Global Evidence Advisory Panel on Education (GEEAP 2023)[17] , show that the availability of digital infrastructure does not automatically guarantee better academic performance. Key factors include the methods of integrating ICT into learning, teacher qualifications, and strategic management of the digital environment.

Intrnational studies also emphasize that the impact of Wi-Fi on academic performance is heterogeneous and context-dependent. According to a global UNESCO report, evidence of technology's impact on learning outcomes is "mixed": certain digital tools are effective for improving specific skills, but the overall picture is not clear.[18] When technology is introduced without adequate systemic support, the result can be zero or even negative. For instance, researchers in Italy analyzed the phased connection of schools to ultra-broadband internet from 2015 - 2017 and found a statistically significant decline in the performance of 8th-grade students in mathematics and their native language.[19] This negative effect was most pronounced among boys from families with low educational levels, especially in cases where the school demonstrated low levels of ICT use in the educational process.[20]

It is likely that access to Wi-Fi without proper pedagogical application led to students to spend more time on non-academic online activities, which negatively affecting their grades. Similar conclusions were drawn in the United States, where an analysis of a school Wi-Fi expansion program showed that it could increase the achievement gap between different student groups without additional pedagogical innovation. More successful students benefited significantly, while

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[10] Ibid.
11 Schleicher, A. and Reiter, J. 2025 . 'Can the targeted use of digital devices in education win over the naysayers?', OECD Education Today, 11 February. https://oecdedutoday.com/can-the-targeted-use-of-digital-devices-in-education-win-over-the-naysayers/#:~:text=computational%20thinking%20and%20self
[12] Ibid.
[13] OECD (2015), Students, Computers and Learning: Making the Connection, PISA, OECD Publishing. http://dx.doi.org/10.1787/9789264239555-en
[14] OECD (2022), Technology use at school and students' learning outcomes: exploring the relationship with new data from Germany. https://www.oecd.org/en/publications/technology-use-at-school-and-students-learning-outcomes_422db044-en.html
[15] Appendices A (Appendices 6, 7, 8)
[16] Appendices A (Appendix 10)
[17] 2023 Cost-Effective Approaches to Improve Global Learning - What does recent evidence tell us are "Smart Buys" for improving learning in low- and middle-income countries? [K. Akyeampong, T. Andrabi, A. Banerjee, R. Banerji, S. Dynarski, R. Glennerster, S. Grantham-McGregor, K. Muralidharan, B. Piper, S. Ruto, J. Saavedra, S.Schmelkes, H. Yoshikawa]. London, Washington D.C., New York. FCDO, the World Bank, UNICEF, and USAID. https://www.worldbank.org/en/topic/teachingandlearning/publication/cost-effective-approaches-to-improve-global-learning
18 UNESCO. (2023) 'Technology in Education', Global Education Monitoring Report 2023. https://gem-report-2023.unesco.org/technology-in-education/#:~:text=technologically%20advanced%20countries%2C%20computers%20and,to%20benefit%20from%20this%20technology
19 Cambini, C., Sabatino, L. and Zaccagni, S. (2024) 'The faster the better? Advanced internet access and student performance', Telecommunications Policy. https://ideas.repec.org/a/eee/telpol/v48y2024i8s0308596124001125.html#:~:text=plausibly%20exogenous%20variation%20in%20the,with%20a%20low%20IT%20usage
20 Ibid.

students from vulnerable groups fell further behind.[21] Therefore, the mere physical presence of the Internet does not guarantee improved academic outcomes - the quality of its use in the educational process is crucial.

Global experience shows that the introduction of Wi-Fi in schools is a hotly debated topic, as its impact on student academic performance can vary and depends on many factors. The 2015 OECD report, *Students, Computers and Learning*,[22] clearly demonstrates that uncontrolled and excessive use of computers can lead to poorer learning outcomes, especially in reading. This may be due to distractions, insufficient integration of technology with learning objectives, or a lack of teacher training. In contrast, the report also highlights that moderate and pedagogically sound use of technology can bring significant benefits. Personalized learning that takes into account the individual needs and learning pace of each student, as well as the use of technology as a support tool for teachers, can increase student motivation, facilitate the understanding of complex concepts, and expand access to learning resources.

The 2023 GEEAP report, *Cost-Effective Approaches to Improve Global Learning*,[23] emphasizes the need for "smart buys" in educational technology. The authors argue that effective solutions combine pedagogical relevance with improved learning outcomes at a reasonable cost. The report warns against "bad buys," such as purchasing large quantities of equipment without adequate pedagogical support and teacher training. In other words, the mere presence of Wi-Fi and computers in schools does not guarantee improved quality of education if teachers do not know how to use them effectively.

Academic John Hattie, a professor at the University of Melbourne, has conducted over 800 meta-analyses to identify the most effective teaching methods. His work, summarized in *Visible Learning (2009, 2017)*,[24] shows that the effect of ICT use in education is moderately positive ($d \approx 0.37$). Hattie emphasizes that this effect increases significantly only with targeted and thoughtful integration of technology into teaching practice.

Therefore, global experience suggests that Wi-Fi in schools can be an effective tool for improving academic performance, but it can also have no positive impact or even lead to negative consequences. Success depends not just on providing internet access, but on creating an environment where it is used to expand access to quality educational materials, engage students in interactive tasks, and ensure teachers have the necessary skills to implement these technologies effectively. Only under such circumstances can investments in Wi-Fi and related technologies deliver the expected results and contribute to improving the quality of education.

2.2. Organization of the educational process. Efficiency, innovative methods, and individualized approaches

Improving efficiency and introducing innovative teaching methods

The availability of Wi-Fi and digital technologies in schools offers significant opportunities to improve the efficiency of the educational process. Efficiency gains come from automating routine tasks and optimizing teaching time. According to a UNESCO report, technology can *"reduce the time spent by students and teachers on technical, low-value tasks, freeing it up for more meaningful educational activities."*[25] For example, teachers can use the internet to quickly collect

[21] Yu, D. (2024) Three chapters in economics of education. Doctoral thesis. Michigan State University. https://d.lib.msu.edu/etd/52229#:~:text=deployment%20data%20and%20student%20performance,this%20study%20finds%20evidence%20that
[22] Ibid.
[23] 2023 Cost-Effective Approaches to Improve Global Learning - What does recent evidence tell us are “Smart Buys” for improving learning in low- and middle-income countries? [K. Akyeampong, T. Andrabi, A. Banerjee, R. Banerji, S. Dynarski, R. Glennerster, S. Grantham-McGregor, K. Muralidharan, B. Piper, S. Ruto, J. Saavedra, S. Schmelkes, H. Yoshikawa]. London, Washington D.C., New York. FCDO, the World Bank, UNICEF, and USAID.
[24] Visible learning: a synthesis of meta-analyses relating to achievement/John A. C. Hattie. https://inspirasifoundation.org/wp-content/uploads/2020/05/John-Hattie-Visible-Learning_-A-synthesis-of-over-800-meta-analyses-relating-to-achievement-2008.pdf
[25] UNESCO (2023) Technology in education. https://gem-report-2023.unesco.org/technology-in-education/

and check online tests or use electronic grade books, which simplifies administrative work and allows more time for teaching and student interaction.

Wi-Fi access also facilitate progressive teaching methods like the "flipped classroom", blended learning, and project-based learning. Educational institutions globally use extensive digital content libraries, including educational videos, simulations, and games. The digitization of textbooks and the creation of open educational resources have increased the availability of this content. For example, countries like Bhutan and Rwanda have digitized textbooks to make them more accessible, while India and Sweden have developed interactive e-textbooks with multimedia elements.[26] Wi-Fi allows these resources to be delivered quickly to every classroom.

Internet access also globalizes the educational experience. Students and teachers can participate in webinars, virtual tours, and international projects. Over 70% of students report that digital devices make learning more interesting,[27] and 76% say technology increases their engagement.[28] This confirms that innovative methods based on Wi-Fi (in particular, interactive presentations, online quizzes, educational platforms such as Google Classroom or Moodle) can significantly improve learning effectiveness.

However, the key to success is proper teacher training and the integration of technology into curricula. International organizations like UNICEF and the OECD emphasize that once internet access is provided, the learning process itself must be adapted. Teachers need training on how to integrate technology into their daily practices.[29],[30] Governments in many countries (e.g., Singapore, Estonia, South Korea) are funding programs to upgrade teachers' digital skills alongside investments in internet access. This comprehensive approach ensures that new technologies yield real benefits.

Individualization of learning

Individualization, or personalization, is a key advantages of internet access in schools. The traditional one-size-fits-all model often fails to account for individual learning paces and interests. Wi-Fi provides tools to adapt the educational process to each student's needs. Modern adaptive learning platforms use algorithms to select tasks that match a student's level, provide immediate feedback, and offer recommendations.[31] This allows students to learn at their own pace. According to UNESCO, digital tech makes it possible to "organize the sequence of learning so that it matches the knowledge base and characteristics of the student," supporting individualized learning paths.[32]

There are many successful examples of this in practice. In the US and Europe, "intelligent" electronic tutoring systems are widespread. In India, educational apps on tablets have helped rural students improve literacy and numeracy skills. All of these technologies require a stable internet connection.

Distance and blended learning, particularly during the COVID-19 pandemic, also highlighted the importance of Wi-Fi for personalization. Students could re-watch recorded lessons, and teachers could use platform data to identify who needed help. The OECD notes that, when used properly, digital technologies can enhance individual learning.[33] The goal is to balance between individual

[26] Ibid.
27 Schleicher, A. and Reiter, J. (2025) 'Can the targeted use of digital devices in education win over the naysayers?', OECD Education Today, 11 February. https://oecdedutoday.com/can-the-targeted-use-of-digital-devices-in-education-win-over-the-naysayers/#:~:text=computational%20thinking%20and%20self
28 University of Connecticut Center for Career Development (2023) Technology in education: Promoting student engagement. https://career.uconn.edu/blog/2023/12/14/technology-in-education-promoting-student-engagement/
[29] UNICEF (2021) Connecting schools has the potential to boost GDP by up to 20 percent in world's least connected nations. https://www.unicef.org/eu/press-releases/connecting-schools-has-potential-boost-gdp-20-percent-worlds-least-connected-nations
30 UNESCO (2023) Technology in education. https://gem-report-2023.unesco.org/technology-in-education/
31 Ibid.
32 Ibid.
33 Schleicher, A. and Reiter, J. (2025) 'Can the targeted use of digital devices in education win over the naysayers?', OECD Education Today, February 11. https://oecdedutoday.com/can-the-targeted-use-of-digital-devices-in-education-win-over-the-naysayers/#:~:text=computational%20thinking%20and%20self

online work with collaborative classroom activities, allowing every student to reach their full potential. Wi-Fi is the infrastructure foundation for such personalized educational trajectories.

At the same time, experts emphasize that technology should not replace live communication and teacher support. The best results are achieved when online work is combined with teacher monitoring. It is also important that individualisation does not lead to student isolation. Successful models combine personal online assignments with classroom discussions and group projects. International experience shows that Wi-Fi, **when used appropriately, is an effective tool for individualising learning.**

2.3. Discipline, motivation, and student engagement

The introduction of wireless internet in schools creates new challenges for student discipline and concentration. A key problem is the distraction of students by non-academic activities during class. According to the OECD, an average of 59% of 15-year-old students report being distracted by other students using gadgets during math lessons.[34] In France, 58% of students admit their own concentration due to the use of digital devices during class.[35] Statistics show a correlation between distraction and lower academic performance: students who are frequently distracted by digital devices score significantly worse on math tests.[36] Therefore, uncontrolled use of wireless Internet access and portable devices during class can negatively affect student discipline and performance.

The digital environment also presents gives new disciplinary risks. Constant internet access means students may encounter inappropriate content or communication during class. UNESCO warns that smartphones and the internet in schools can lead to "student distraction and disruption of the learning process" and make children vulnerable to cyberbullying, inappropriate content, and privacy violations.[37,38] These factors negatively impact the psychological climate and discipline.

In response, many countries have implemented regulatory measures. As of 2023, about 25% of countries worldwide have banned the use of smartphone use during classes at the national level.[39] This includes France, China, Bangladesh, and some US states.[40] Studies in Belgium, Spain, and the United Kingdom have confirmed an improvement in academic performance after introducing a "no smartphone" policy.[41] In its 2023 global report, UNESCO recommended considering a global ban on smartphones during the learning process if they have no direct educational value.[42] Even a nearby phone receiving notifications can disrupt concentration; one study showed it can take up to 20 minutes to fully refocus after being distracted by a notification.[43]

International experience points to several ways to ensure discipline:

34 OECD (2024) Students, digital devices and success. https://www.oecd.org/content/dam/oecd/en/publications/reports/2024/05/students-digital-devices-and-success_621829ff/9e4c0624-en.pdf#:~:text=negatively%20impact%20students'%20academic%20performance,significantly%20lower%20in%20maths%20tests
35 Ibid.
36 Ibid.
37 World Economic Forum. (2023) Online learning: How can we bridge the digital divide and make the online environment safer? https://www.weforum.org/stories/2023/08/online-learning-digital-divide-mobile-phone-school-education/#:~:text=,make%20the%20online%20environment%20safer
38 OECD. (2024) Students, digital devices and success. https://www.oecd.org/content/dam/oecd/en/publications/reports/2024/05/students-digital-devices-and-success_621829ff/9e4c0624-en.pdf#:~:text=negatively%20impact%20students'%20academic%20performance,significantly%20lower%20in%20maths%20tests
39 World Economic Forum. (2023) Online learning: How can we bridge the digital divide and make the online environment safer? https://www.weforum.org/stories/2023/08/online-learning-digital-divide-mobile-phone-school-education/#:~:text=,make%20the%20online%20environment%20safer
40 Ibid.
41 Ibid.
42 Ibid
43 Ibid

The first is the development of a clear policy for the use of devices: many schools establish rules for when and how the intrnet can be used.

The second is the implementation of technical solutions: school Wi-Fi networks can be equipped with filters to block access to social media, gaming sites, and harmful content.

The **third** is educational activities: students are taught digital literacy and etiquette, fostering a culture of responsible internet use.

Practice shows that when students are engaged in interesting activities, the risk of distraction is reduced. OECD experts conclude that it is important not just to ban technology, but *to* "ensure that technology is used in the best interests of students and teachers," which requires proper management.[44] Thus, maintaining discipline in a connected classroom requires a combination of policies, technological solutions, and the development of self-discipline skills in students.

Alongside these challenges, wireless internet offers significant benefits for motivating and engaging students. Access to interactive content and multimedia materials can make learning more attractive. Research consistently shows that technology increases students' interest in learning, with about three-quarters of students finding lessons with digital tools more engaging.[45,46] This effect is seen across is seen across different countries and age groups. The use of gamification (earning points, badges) in primary schools in Spain and the US has led to improved attendance and engagement. In South Korea, integrating tablets with educational apps has increased motivation in subjects like mathematics.

Student engagement is also enhanced because the internet allows everyone to explore topics of interest. A student interested in a particular subject can easily find more information, watch videos, or conduct virtual experiments. This stimulates research motivation. According to an OECD survey, over 70% of students said digital tools help them understand complex topics more easily.[47] This feeling of success significantly influences a student's motivation to continue learning.

Wi-Fi also accommodates different learning styles. Students can access materials in various formats - text, audio, video, and interactive. It also provides access to assistive technologies for students with special educational needs. UNESCO emphasizes that modern platforms increasingly have accessibility features that help students with disabilities participate on an equal footing.[48]

The motivational effect of technology is not automatic; **it depends on the pedagogical design of the lessons**. If a lesson is simply digitized but remains uninteresting, engagement will not increase. According to a UNESCO study, technology should be used to enrich learning, not just distract from it.[49]

Overall, international experience shows that **Wi-Fi in schools**, despite potential discipline issues, can be **a powerful driver of student motivation and engagement, provided clear rules are established and lessons are designed to leverage the digital environment in.**

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44 OECD. (2024) Students, digital devices and success. https://www.oecd.org/content/dam/oecd/en/publications/reports/2024/05/students-digital-devices-and-success_621829ff/9e4c0624-en.pdf#:~:text=negatively%20impact%20students'%20academic%20performance,significantly%20lower%20in%20maths%20tests

45 Schleicher, A. and Reiter, J. (2025) 'Can the targeted use of digital devices in education win over the naysayers?', OECD Education Today, 11 February. https://oecdedutoday.com/can-the-targeted-use-of-digital-devices-in-education-win-over-the-naysayers/#:~:text=computational%20thinking%20and%20self

46 UNESCO. (2023) 'Technology in Education', Global Education Monitoring Report 2023. https://gem-report-2023.unesco.org/technology-in-education/#:~:text=technologically%20advanced%20countries%2C%20computers%20and,to%20benefit%20from%20this%20technology

47 Schleicher, A. and Reiter, J. (2025) 'Can the targeted use of digital devices in education win over the naysayers?', OECD Education Today, 11 February. https://oecdedutoday.com/can-the-targeted-use-of-digital-devices-in-education-win-over-the-naysayers/#:~:text=computational%20thinking%20and%20self

48 UNESCO. (2023) Technology in education. https://gem-report-2023.unesco.org/technology-in-education/

49 UNESCO. (2023) 'Technology in Education', Global Education Monitoring Report 2023. https://gem-report-2023.unesco.org/technology-in-education/#:~:text=technologically%20advanced%20countries%2C%20computers%20and,to%20benefit%20from%20this%20technology

2.4. Financial and economic aspects of Wi-Fi implementation

Costs and investments

Deploying wireless internet in educational institutions requires significant financial investments, both one-time and recurring. Key expenditures include purchasing and installing network equipment, ensuring sufficient internet bandwidth, equipping students with devices, and network maintenance. Indirect costs, such as teacher training, developing digital content, and ensuring cybersecurity, are also important and often underestimated.[50]

School Wi-Fi is usually funded by governments, often with support from international organizations and the private sector. The global Giga initiative, launched by UNICEF and the ITU, works with governments and companies to connect schools worldwide, promoting innovative financing models.[51]

In countries with limited resources, prioritizing budget allocations is crucial. If schools lack textbooks, basic equipment, or qualified teachers, significant investments in technology may be ineffective. UNESCO emphasizes that in low- and middle-income countries, spending on expensive technology "may set the world back in achieving education for all."[52] Historically, developed countries achieved high levels of education before the digital age.[53] While students can learn without the internet, 21st-century education requires digital skills, so ignoring investment in Wi-Fi is not an option.[54]

Many governments try to find a compromise, such as connecting schools where basic needs are already met or attracting targeted funding for technological modernization.

Ongoing expenses, such as internet subscription fees and equipment maintenance, must also be budgeted for. The economic efficiency of these expenditures depends on how productively the internet is used in the educational process.

Profitability and economic efficiency

Despite the significant costs, research shows that when used effectively, school internet can provide high returns. One approach is to calculate the impact on students' future earnings. The Texas study mentioned earlier estimated that an additional economic $600,000 in annual internet spending was associated with an increase graduates' projected lifetime income of $820,000 - $1.8 million. Even after accounting for losses from disciplinary issues, the net profit still exceeded the investment.[55] For every $1 spent, schools received up to $3 in economic benefits in the form of human capital. This is a strong argument in favor of investing in educational infrastructure, including Wi-Fi, as economically viable and *profitable* in the long term.

At the macroeconomic level, connecting schools to the internet is an investment in national development. A report by the Economist Intelligence Unit (supported by UNICEF and Ericsson) found a direct correlation between internet penetration in education and economic growth. According to their analysis, every 10% increase in the proportion of connected schools can lead

[50] Ibid.
[51] UNICEF. (2025) Giga. https://www.unicef.org/innovation/giga#:~:text=Giga%2C%20an%20initiative%20launched%20by,time%20after%20COVID
[52] UNESCO. (2023) ‘Technology in Education’, Global Education Monitoring Report 2023. https://gem-report-2023.unesco.org/technology-in-education/#:~:text=technologically%20advanced%20countries%2C%20computers%20and,to%20benefit%20from%20this%20technology
[53] Ibid.
[54] Ibid.
[55] Rice University. 2021. Internet-access spending improves academic outcomes, study of Texas schools finds. https://news.rice.edu/news/2021/internet-access-spending-improves-academic-outcomes-study-texas-schools-finds#:~:text=improvement%20in%20commended%20performance%20in,the%20number%20of%20broadband%20providers

to a 1.1% increase in GDP per capita.[56] For a country like Niger, bringing school internet coverage to the level of a developed country like Finland could increase GDP per capita by almost 20%.[57]

A quality education impacts the productivity of the future workforce. Workers with digital skills are more innovative and qualified, contributing to job creation.[58] Investing in school Wi-Fi is an investment in human capital that drives economic growth.

The economic efficiency of Wi-Fi implementation also lies in the optimization of costs in the education system. Digital resources can reduce the cost of printing textbooks. National electronic libraries, like those in Ethiopia and Bangladesh, provide free access to educational materials.[59] Online teacher training is more cost-effective than in-person training.

The economic viability of investing in Wi-Fi depends on its impact on educational outcomes. The availability of the internet alone does not guarantee an increase in knowledge. Conscious and targeted use of Wi-Fi ensures a high return on investment.[60] Successful school connectivity requires cooperation between the state, business, and civil society.[61],[62]

2.5. Chapter conclusions

nstalling Wi-Fi in schools offers significant opportunities to improve student academic performance, modernize teaching methods, personalize learning, and increase student motivation. At the same time, it creates new challenges, such as distraction, disciplinary issues, and the need for significant financial investment and careful implementation.

The experience of successful education systems shows that maximum effectiveness is achieved when technological infrastructure is integrated with investments in human capital—qualified teachers, adapted curricula, and student support in the digital environment. Organizations like UNESCO and the OECD emphasize that technology is only a tool, and its effectiveness depends on its rational use for educational purposes.[63]

International practice shows that with effective management, internet access in schools can become a powerful driver of innovation, helping to prepare students for digital challenges, reduce educational inequality, and achieve significant socio-economic results. However, this requires focusing on the needs of students and teachers and adapting technology to those needs, not the other way around.[64] A scientifically sound, people-centered approach ensures that every investment in Wi-Fi contributes to the goal of providing quality education for all.

[56] UNICEF (2021) Connecting schools has the potential to boost GDP by up to 20 percent in world's least connected nations. https://www.unicef.org/eu/press-releases/connecting-schools-has-potential-boost-gdp-20-percent-worlds-least-connected-nations
[57] Ibid.
[58] Ibid.
[59] UNESCO. (2023) 'Technology in Education', Global Education Monitoring Report 2023. https://gem-report-2023.unesco.org/technology-in-education/#:~:text=technologically%20advanced%20countries%2C%20computers%20and,to%20benefit%20from%20this%20technology
[60] UNICEF. (2021) Connecting schools has the potential to boost GDP by up to 20 percent in world's least connected nations. https://www.unicef.org/eu/press-releases/connecting-schools-has-potential-boost-gdp-20-percent-worlds-least-connected-nations
[61] Ibid.
[62] Ibid.
[63] UNESCO. (2023) 'Technology in Education', Global Education Monitoring Report 2023. https://gem-report-2023.unesco.org/technology-in-education/#:~:text=technologically%20advanced%20countries%2C%20computers%20and,to%20benefit%20from%20this%20technology
[64] World Economic Forum. (2023) Online learning: How can we bridge the digital divide and make the online environment safer? https://www.weforum.org/stories/2023/08/online-learning-digital-divide-mobile-phone-school-education/#:~:text=,make%20the%20online%20environment%20safer

Chapter 3. The Ukrainian Context

3.1. Review and analysis of national data on internet access in general secondary education

3.1.1. Analysis of Data from the State Service for Quality Education of Ukraine

To obtain information on the impact of internet coverage on the educational process, the project team sent an official request to the State Service for the Quality of Education of Ukraine (SSQEU). While the Service conducts monitoring studies on the quality of education and resource provision, it does not collect official statistics on this specific issue and is not the administrator of such data. For this report, the following monitoring studies conducted by the Service were analyzed:

1. **Results of a monitoring study (survey) of the preparedness of preschool, general secondary, and extracurricular education institutions for the 2024/2025 academic year** (see *Appendix 1* in *Appendix A*).

This study analyzed the readiness of Ukrainian educational institutions, particularly concerning the physical and psychological safety of participants, the adequacy of material and technical resources, the continuity of the educational process (including readiness for power outages), and the implementation of distance learning technologies. The study covered 996 GSEIs (54% rural, 11% in towns, 25% in cities).

The study found that in the 2024/2025 academic year, 57% of students attended in person, 21% in a mixed mode, and 22% remotely. This indicates the system's flexibility in balancing safety with educational needs.

Regarding teachers' access to technology, 40% used computers provided by their institution, 28% received equipment for home use, and 29% used their own computers. Only 2% reported a lack of necessary equipment. A parallel survey of parents found that 46% of children had access to personal devices, 18% used shared family devices, and 63% had their own smartphones for learning. Only 1% reported a complete lack of technical equipment.

However, the study contains no information about the level of internet access or the availability of Wi-Fi in educational settings or shelters. This absence highlights the need for additional monitoring or the use of other data sources for a comprehensive assessment of digital infrastructure in GSEIs.

2. Report on the results of a nationwide monitoring study of education quality in GSEIs under martial law (see *Appendix 2* in *Appendix A*)

This study, initiated by the MES and the SSQEU, tracked the learning outcomes of 6th and 8th-grade students in Ukrainian language and mathematics. The analysis showed that the widespread use of Wi-Fi and digital tools is essential for organizing online testing and providing access to educational resources.

However, there was no statistically significant correlation between students' access to technical devices (smartphones, computers) and their performance in the Ukrainian language. Performance was higher for students who used large-screen devices (computers, laptops) compared to those who used smartphones. Higher levels of digital literacy and confidence in using gadgets correlated with better test results. Differences in the quality of the internet connection between schools were not analyzed separately, but technical support remained a key organizational factor.

Thus, student performance depends not only on the availability of digital tools but also on their proficiency in using them and the type of device used. The use of smartphones for completing tasks was found to be less effective in terms of academic results.

A national sample of aggregated data on the answers submitted by students in grades 6 and 8, disaggregated by subject from educational institutions, including explanations and links to a selection of correct answers, is presented in *Appendix 3, Appendix 4* (see Appendices A) to this report.

3.1.2. Analysy of Data from the Ukrainian Center for Educational Quality Assessment

To analyze the impact of ICT infrastructure on academic performance, project specialists requested information from the Ukrainian Center for Educational Quality Assessment (UCEQA) and interviewed its director. The hypothesis was that combining Wi-Fi access with investments in teacher training and quality educational content improves student performance, whereas isolated Wi-Fi implementation does not..

Next, we examine how the level of ICT availability in educational institutions affects the reading scores of 15-year-old students according to the PISA-2018 study, and changes in this ICT availability according to the PISA-2018 results (see Appendix 7 at*Appendices A*).

Level of ICT resources in Ukraine compared to OECD countries

According to the PISA-2018 study, see Appendix 6 at*Appendices A*), the ICT resource availability index (ICTRES) in Ukraine was much lower than in most reference countries. The index was significantly higher among 15-year-old students attending secondary schools in **large cities** than among those attending **secondary schools** in **small towns** (Figure 2). Ukrainian students were better equipped than those in Georgia and Moldova but less so than their peers in Belarus, Hungary, Slovakia, Poland, Estonia, and the OECD average (Figure 1).

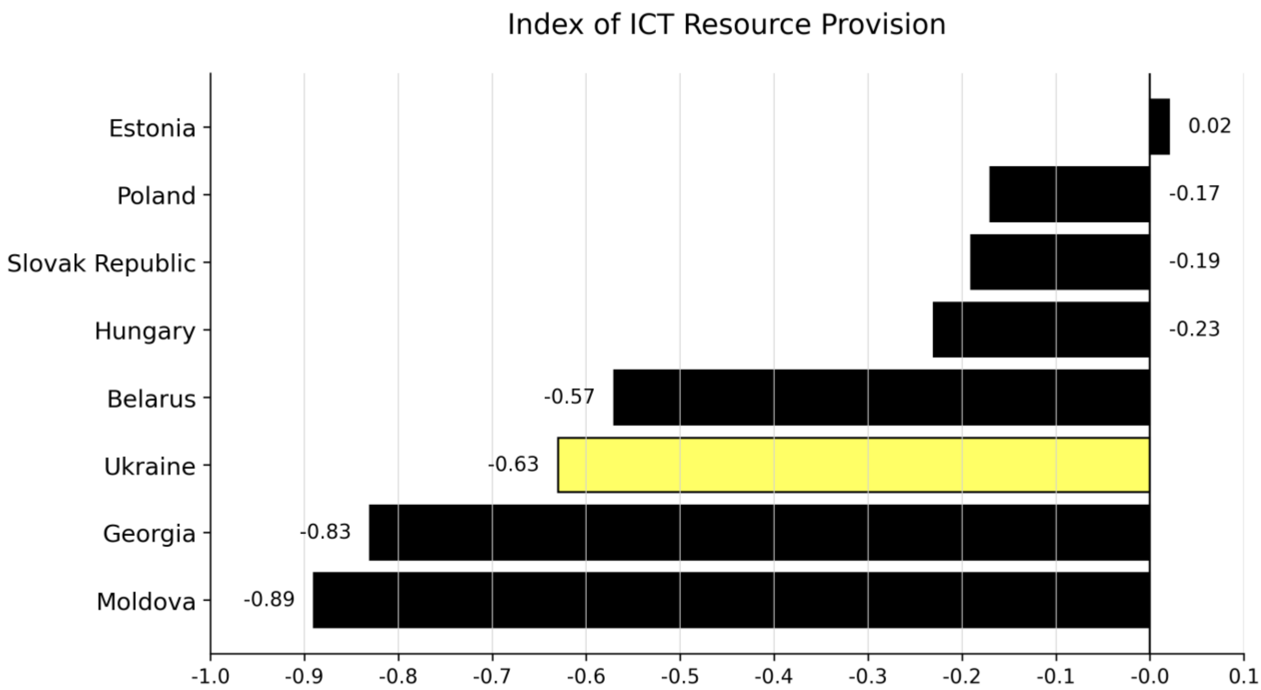

Figure 1. ICT resource availability index (early 2018)

The index value is standardized: the OECD average is 0, and the standard deviation is 1. If the ICTRES index is > 0, the provision is higher than the OECD average, if < 0 — lower At the same time, it was found that the vast majority of 15-year-old students have basic technical means for digital learning, but a detailed analysis of the home and school environments reveals significant differences.

In absolute terms, Ukrainian students had:

- 89% access to computers for homework;
- 98% access to the internet;
- 59% access to educational software;
- 44% have at least one tablet;
- 46% have one computer (desktop or laptop), 33% have two computers, 12% have three or more;
- 68% access to multiple more mobile phones with internet.

However, 81% lacked electronic textbooks, limiting distance learning options. Approximately 70% of school administrators noted a shortage of digital equipment, and 60% cited a lack of qualified IT personnel.

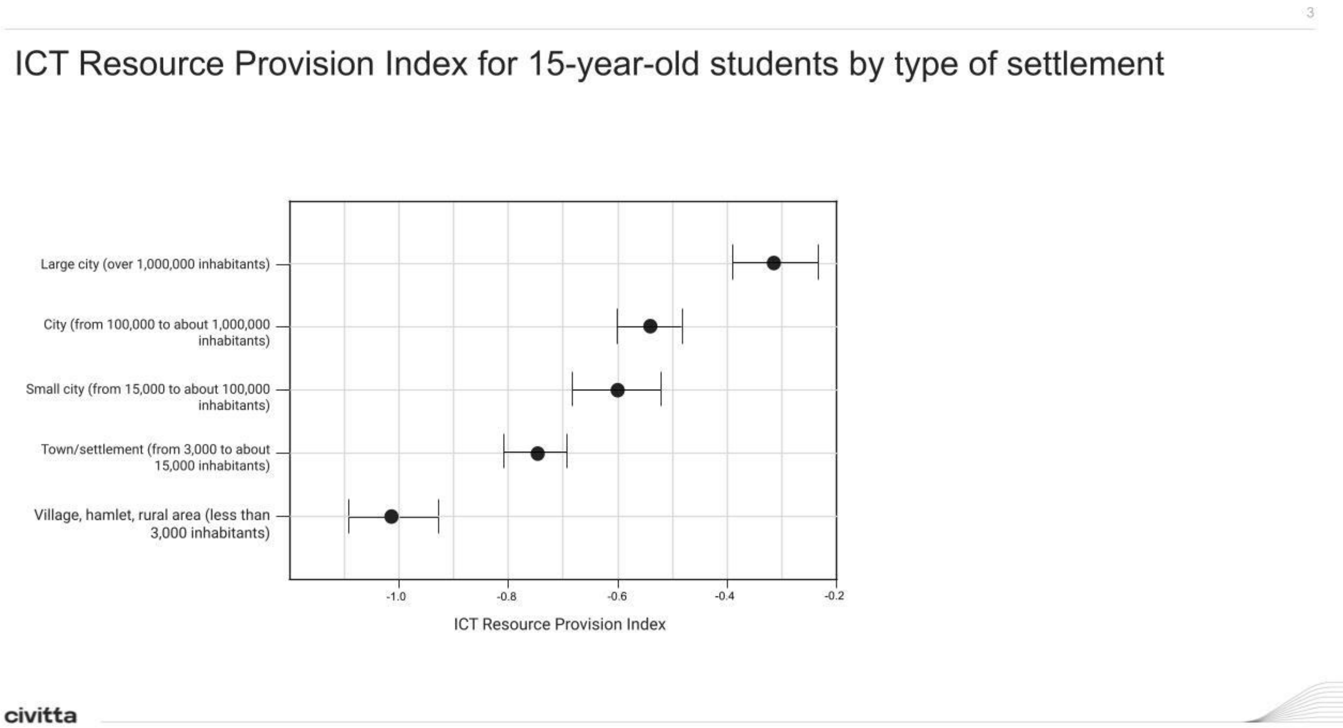

Figure 2. Index of 15-year-old students' access to ICT resources by type of settlement. (Prepared by UCEQA experts). Report "PISA-2018: UKRAINE IN THE SPOTLIGHT")[65]

[65] (see Appendix 6 in Appendix A)

In addition, according to the PISA-2018 study[66] , students with higher levels of ICT resources at home show **higher reading scores**. A classic increase in ICTRES **by one unit** results in a significant increase in results in all reference countries (Figure 3).

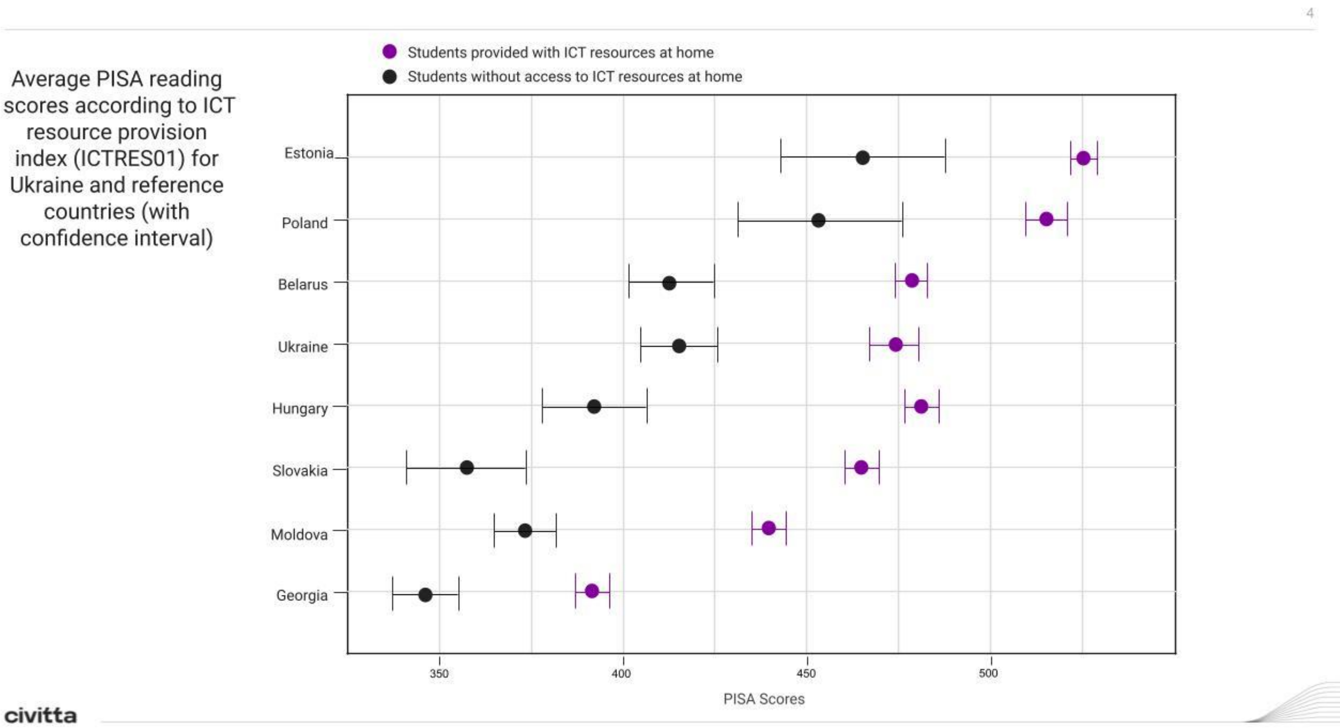

Figure 3. Average PISA reading scores according to ICT resource availability (ICTRES01) for Ukraine and reference countries (with confidence interval). (Prepared by UCEQA experts. Report "PISA-2018: UKRAINE IN THE SPOTLIGHT")[67]

This is primarily explained by the higher level of accessibility of educational resources at any time. The availability of technology at home ensures the continuity of the learning process, allows students to work at their own pace, use additional online materials, prepare for classes, and do their homework without having to depend on the school's computer class schedule or alternatives such as libraries or gadgets belonging to friends or relatives. This accessibility creates a favorable environment for the development of digital literacy, which is an important component of modern education. Students who regularly use technology have higher levels of information search and data manipulation skills, as well as the ability to work with learning platforms and electronic resources.[68(,)69] However, with the development of digital technologies, especially with the widespread introduction of generative artificial intelligence, new educational challenges are emerging. Students have been given the opportunity to automate some of their learning tasks, such as writing essays, solving problems, or preparing projects. This can lead to a reduction in intellectual effort, superficial learning, and a loss of motivation to learn. Generative AI is becoming a tool that, without proper control and supervision, can negate students' independent cognitive activity. Thus, the availability of digital devices at home is undoubtedly a positive factor that

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[66] (Appendix 6 in *Appendix A)*

[67] (see Appendix 6 in Appendix A)

[68] The Guardian. 20247 Estonia eschews phone bans in schools and takes leap into AI. https://www.theguardian.com/education/2025/may/26/estonia-phone-bans-in-schools-ai-artificial-intelligence

[69] NaUrok. 2024. Use of learning technologies and student development to achieve expected learning outcomes. https://naurok.com.ua/vikoristannya-tehnologiy-navchannya-rozvitku-uchniv-dlya-dosyagnennya-ochikuvanih-rezultativ-navchannya-436552.html

contributes to improved learning outcomes.[70] At the same time, it requires new approaches to shaping digital ethics, developing skills for responsible use of technology, and ensuring a balance between student support and the development of their independence.

It is also worth noting that the PISA-2022 report[71] presents students' interaction with ICT through the prism of three main aspects:

- access to technology,
- means and frequency of use,
- developed digital competencies.

For example, ICT solutions can be used to support teachers' activities outside the classroom (teachers can use ICT to communicate with colleagues and promote the development of inclusive and cross-curricular teaching practices). In addition, ICT can be used to communicate with parents and create online communities that bring together teachers, parents, and students. Teachers can rely on ICT to plan their courses, share materials with students, and track student work and progress. Overall, ICT infrastructure can simplify administrative tasks and processes, thereby freeing up time for more meaningful activities that can benefit student achievement and well-being (PISA 2022 Assessment and Analytical Framework, p. 245).

Learning with ICT infrastructure can influence students' cognitive outcomes (and other outcomes) through interaction with teaching strategies and student engagement in learning. This emphasizes that a computer or gadget does not work autonomously: the effectiveness of ICT in learning depends on how teachers integrate them into their lessons and how actively students are involved in the process. In other words, the quality of interaction between technology, pedagogy, and student motivation is more important (PISA 2022 Assessment and Analytical Framework, p. 246).

Students who have a positive and relaxed attitude toward ICT in any situation are likely to spend more time on it, put more effort into it, and be more positive about homework if they can use ICT to do it. This, in turn, increases their motivation and the quality of their homework (PISA 2022 Assessment and Analytical Framework, p. 247).

The report highlights that education policies aimed at ensuring or stimulating investment in ICT in schools or directly for students usually do not distinguish between access to technology and its practical use, which often leads to little or no improvement in academic performance. At the same time, empirical evidence suggests that investment in ICT contributes to the development of computer skills and overall digital literacy, and that specialized digital learning resources can have a positive impact on students' cognitive achievements. In addition, reducing waiting times for access to computers may explain the observed benefits of additional resources, and the provision of ICT does not impair social well-being and interpersonal interaction. The benefits of targeted investments in high school students are particularly noticeable, while unregulated use of technology during leisure time can distract from learning. Finally, the lack of a link between internet speed and educational achievement points to the need for careful documentation of the availability, accessibility, and quality of ICT resources, with a clear distinction between those

[70] World in a minute. 2024. How Generative AI Fuels Metacognitive Laziness in Education and Solutions. https://worldinminute.com/how-generative-ai-fuels-metacognitive-laziness-in-education-and-solutions/

[71] OECD. 2022. PISA-2022 Assessment and analytical framework. https://www.oecd.org/content/dam/oecd/en/publications/reports/2023/08/pisa-2022-assessment-and-analytical-framework_a124aec8/dfe0bf9c-en.pdf

intended directly for the education of 15-year-old students. (PISA 2022 Assessment and Analytical Framework, p. 254).

In today's educational environment, ICT resources specifically designed to support the learning process show significant potential for improving students' cognitive achievements. Such resources include both software solutions (educational platforms, massive open online courses, educational games, intelligent tutoring systems) and hardware (interactive whiteboards, projectors, etc.). They can be classified into three main categories: 1) digital content (online courses, e-textbooks, multimedia modules) that provides semantic content; 2) communication and tracking tools (platforms for interaction between schools, parents, and students), which serve as functional teaching materials; 3) virtual environments and adaptive tutoring systems focused on the formation of specific didactic skills. Detailed documentation of the technical and pedagogical attributes of each resource (in particular, the mode of connection to the network, availability outside the educational institution, and the degree of adaptation of the content by a specialist or teacher) makes it possible to assess the level of interactivity and individualization of learning, which is key to the effective integration of ICT into the educational process. (PISA 2022 Assessment and Analytical Framework, p. 255).

Thus, summarizing the conclusions of the comprehensive analysis of PISA-2022 in section 3.2.1, we note that the greatest positive impact of ICT is observed in students who have quality access to technology, use it regularly and consciously for learning, develop digital competencies, and receive support from teachers. At the same time, excessive or uncontrolled use of digital resources, or their absence, creates educational inequality and can lead to lower academic performance.

In addition, during a focus group interview with the PISA national coordinator in Ukraine, the project team concluded that management decisions and the content of educational practices also have a significant impact on the effective use of ICT resources. As the coordinator noted, *"there are specific global studies... that show that some access, but not a complete transition of education to a digital environment, but simply the availability of access to these resources, is associated with an increase in academic performance*"; in addition, "*the moderate addition of individual elements of distance computerized learning has a positive* effect"; and, finally, "*if the GSEIs supports the provision of opportunities for teachers and students to master digital skills, organize work with any digital services... students gain the necessary experience to prepare for PISA assessment*."

The analysis and field research presented confirm the conclusions of the quantitative analysis: ICTRES itself has a positive "classic" effect on reading outcomes, but its net impact depends significantly on how well the use of digital tools is institutionalized in the educational process in terms of organization and methodology. At the same time, according to PISA-2018, predicted reading performance is determined by three interrelated factors: geographical location (city or region), level of ICT resource availability (at school and at home), and the socio-economic status of students. A higher level of ICTRES is traditionally associated with a significant increase in the average reading score, but after controlling for SES, this effect is significantly reduced and, in some countries, even becomes negative. This suggests that the positive impact of ICT characteristics largely reflects inequalities related to socio-economic conditions, rather than just technical access to digital tools.

Therefore, improving reading literacy requires not only investment in ICT infrastructure, but also an integrated approach that considers socio-economic determinants and provides methodological and organizational support for the implementation of digital solutions.

3.1.3. Analysis of Data from the Institute of Educational Analytics (IEA)

Compared to 2018, digitalization has improved across Ukraine. The updated statistical indicators for general secondary education as of the 2024-2025 academic year are presented below in graphs selected from the official data sets of the State Scientific Institution "Institute of Educational Analytics" (IEA) for the purpose of researching the provision of ICT infrastructure to general secondary education and determining the potential impact of Wi-Fi coverage on academic performance of students in accordance with the results presented in the PISA-2018 study, which are described in detail in section 3.1.2.

Based on official data on the material and technical base and the use of modern information technologies in general secondary education institutions (excluding special general secondary education institutions) from the MES of Ukraine, other ministries and departments, and private educational institutions (2024/2025 academic year) (see *Appendix 5* in *Annexes A)*, a comprehensive analysis of the digital infrastructure of general secondary education institutions across the country and, in particular, in the city of Kyiv, which served as a pilot for this study, was carried out.

(Figure 5) illustrates the change in the proportion of GSEIs with Internet access across urban and rural areas between the 2017-2018 and 2024-2025 academic years.

In urban areas, Internet connectivity has experienced a slight decline - from 98.7% in 2018 to 94.6% in 2025. This drop may be attributed to a range of factors, including ongoing infrastructure upgrades, modifications in data collection methodologies, or disruptions caused by martial law.

Conversely, rural areas have shown a marked improvement. The share of GSEIs connected to the Internet increased significantly - from 88.6% to 96.5% - indicating targeted efforts to advance digitalization in education and to narrow the urban-rural digital divide. This progress contributes directly to the improvement of the ICT Resource Availability Index (ICTRES), as referenced in (Figure 4).

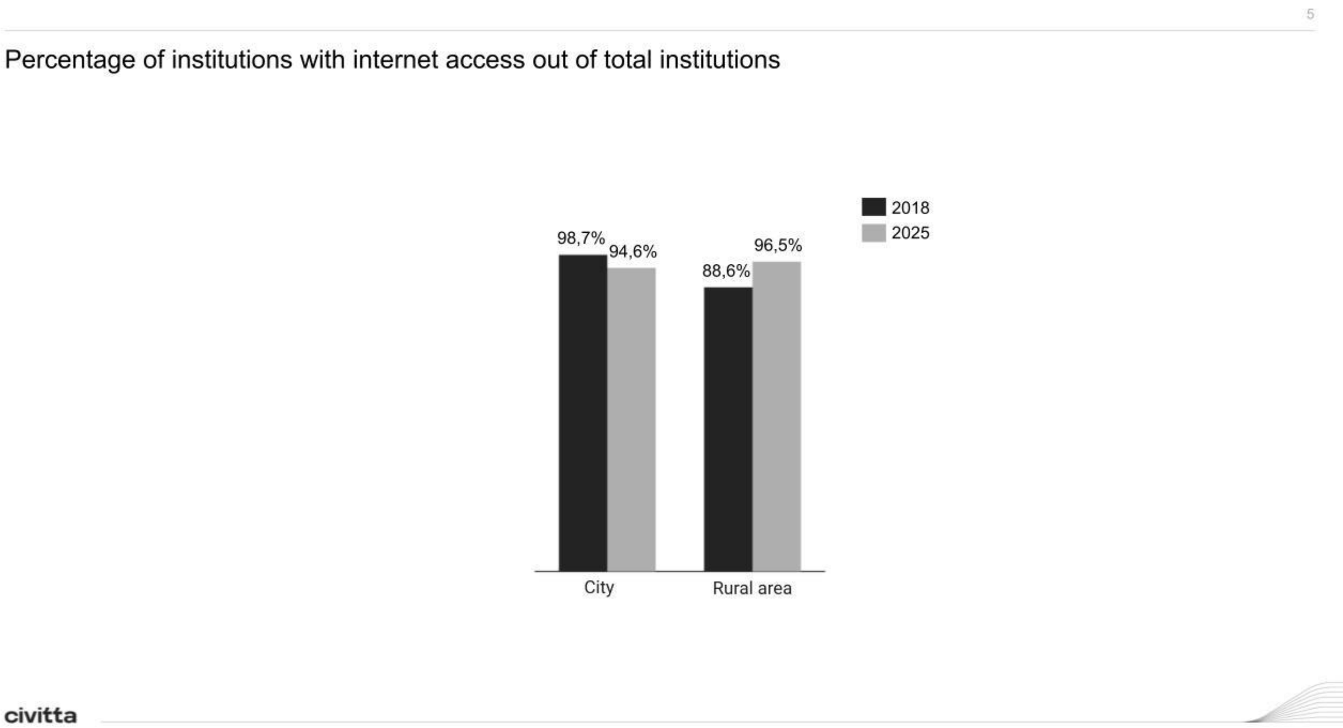


Figure 4. Percentage of institutions with internet access out of the total number of institutions

According to the graph (Figure 6), 96.5% of villages have Internet access, which is very high for rural areas. In EU countries, this figure averages 91%.[72]

[72] Eurostat. 2024. Access to internet in urban and rural areas in 2023. https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20241122-1

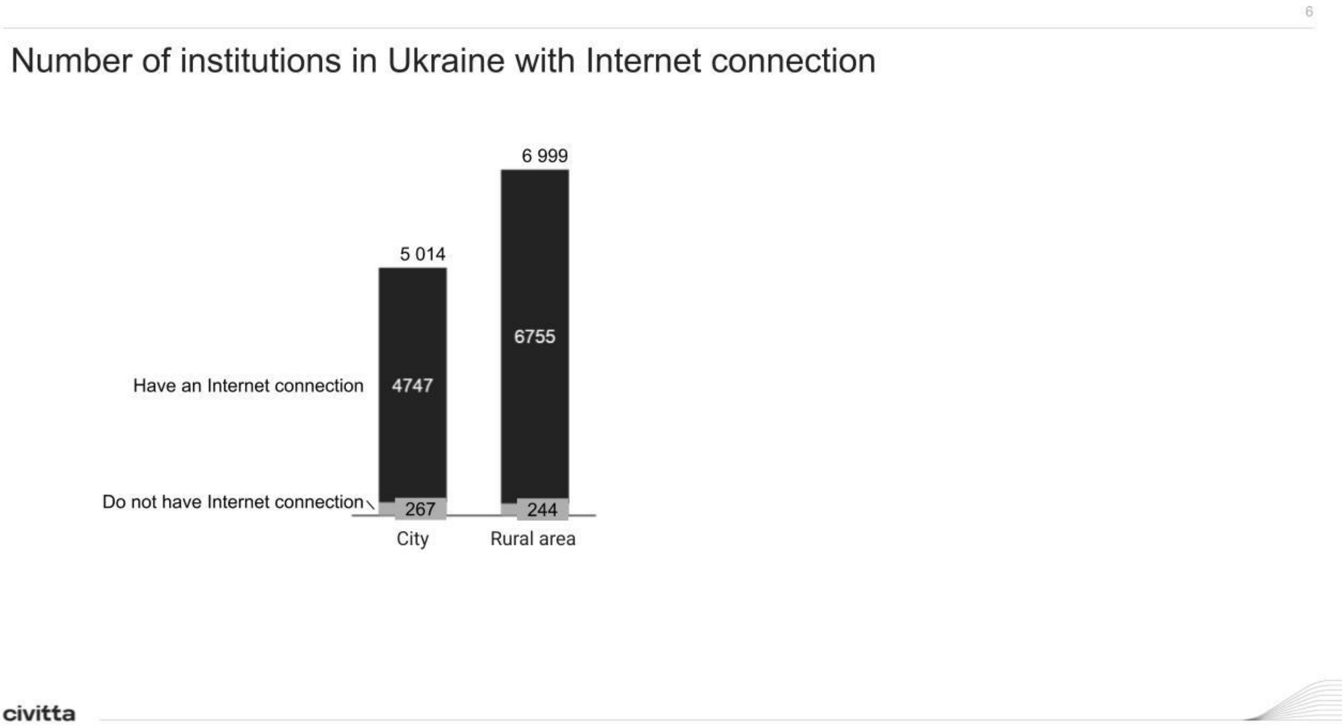


Figure 5. Number of institutions in Ukraine with internet connection

However, a significant gap remains in wireless internet quality. In cities, 42% of institutions have high-speed internet (over 100 Mbps), while 33% have no wireless internet at all. In rural areas, 54.8% of schools lack a wireless connection (Figure 6).

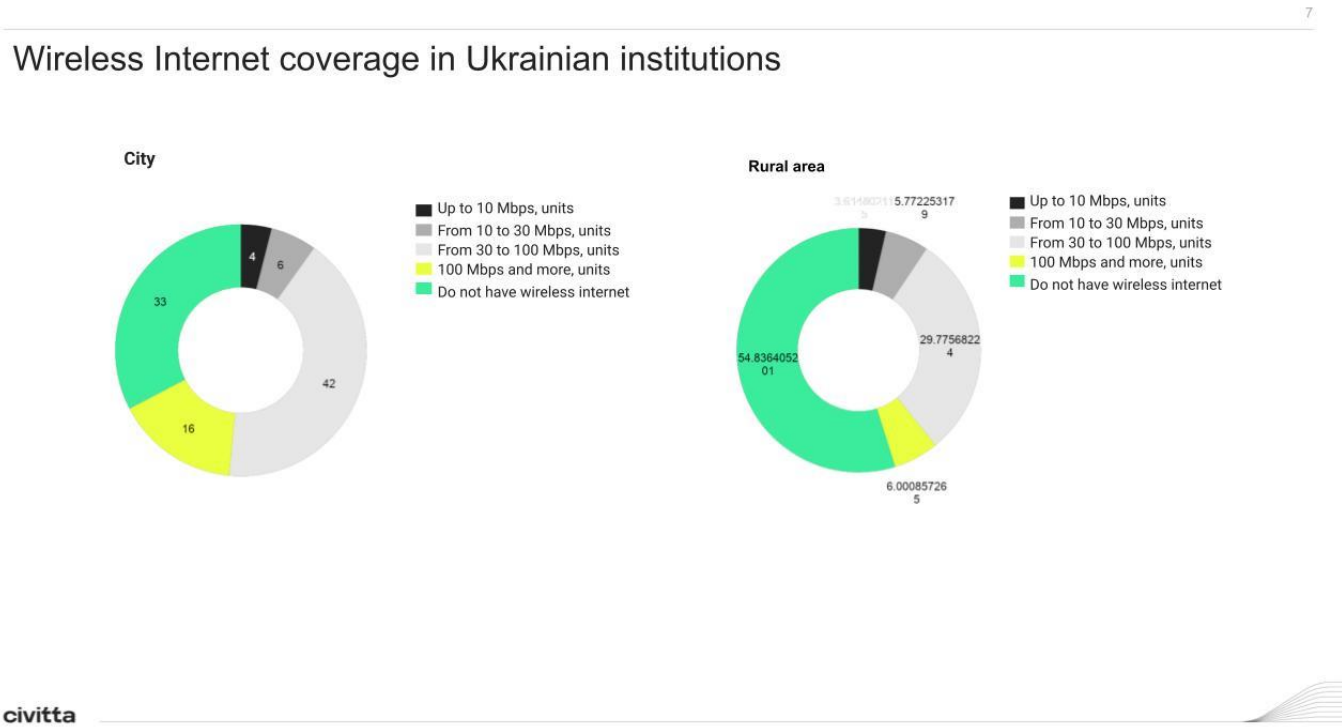


Figure 6. Wireless Internet coverage in institutions in Ukraine

In Kyiv, which served as the pilot city for this study, 92.2% of educational institutions are equipped with Wi-Fi for educational purposes (Figure 8), and 91% have speeds over 30 Mbps, which is sufficient for modern digital services (Figure 9).

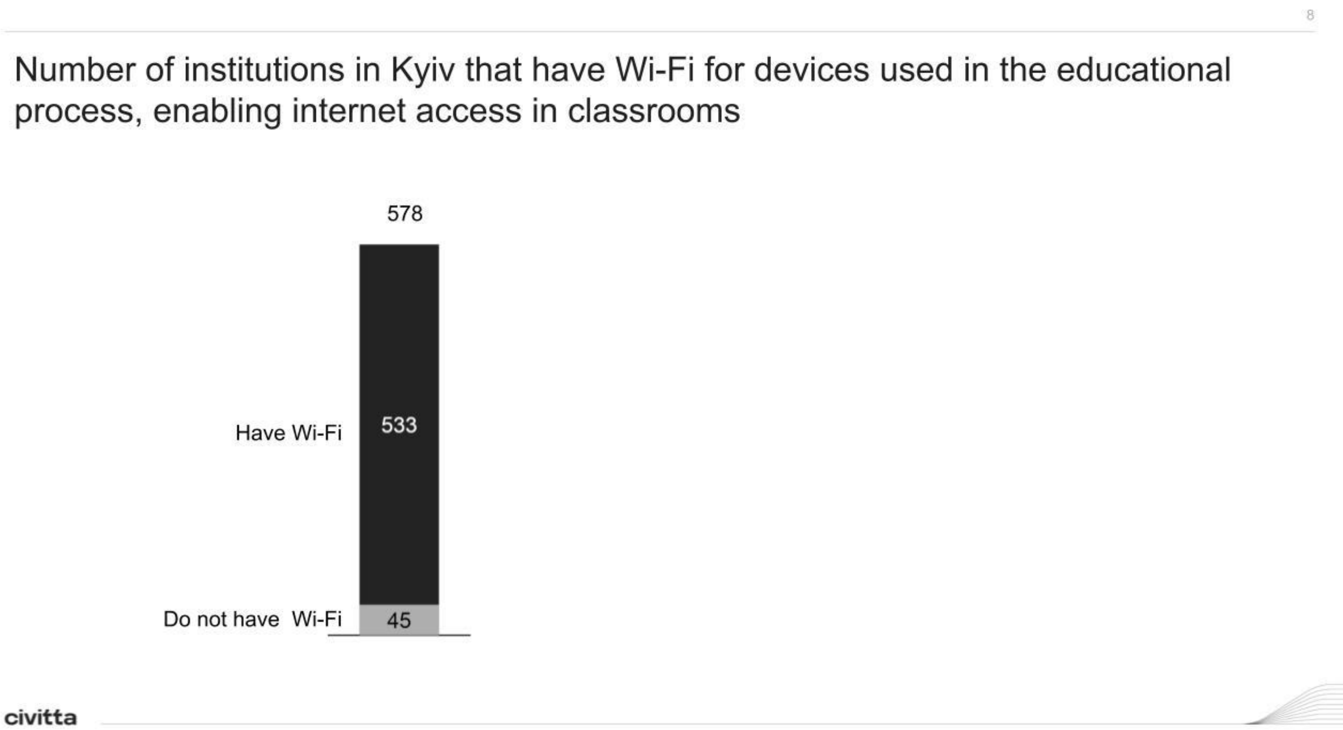


Figure 7. Number of institutions with Wi-Fi for educational devices in Kyiv.

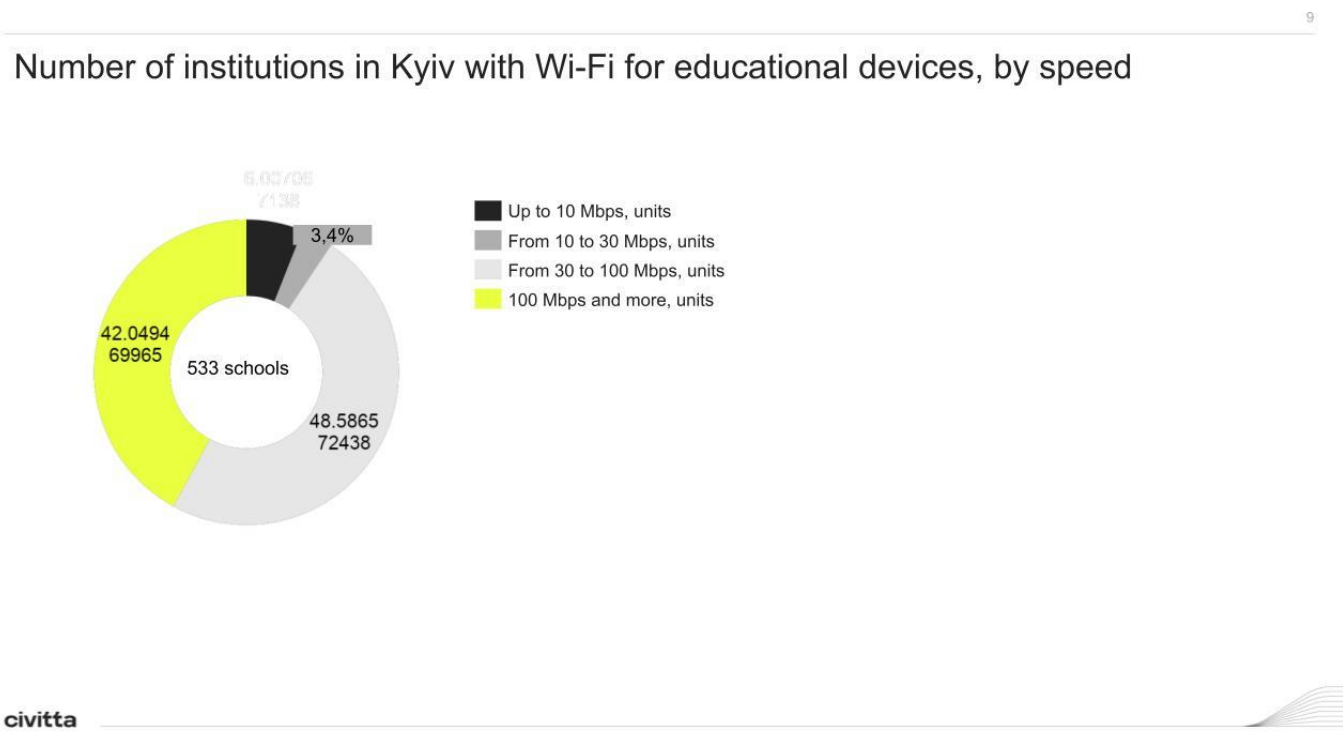


Figure 8 . Number of institutions in Kyiv with Wi-Fi for educational devices, by speed

To conduct an in-depth study, we analyzed information about the connection of secondary schools to wireless infrastructure in accordance with the goals and objectives of the "Comprehensive City Target Program "Digital Kyiv" for 2024-2025, approved by the Kyiv City Council on December 7, 2023, No. 7516/7557.

In accordance with the Law of Ukraine "On General Secondary Education," educational institutions must be provided not only with Internet access, but also with full wireless coverage throughout the entire educational facility. This means that simply laying cable or installing a single router in a classroom is not enough - a comprehensive technical solution is required to ensure stable Wi-Fi coverage throughout the school.

3.2. Academic performance of students in pilot GSEIs based on “Unified School” Data

Research design and methodology of the study was aimed to assess the relationship between wireless internet availability and academic performance in Kyiv-based GSEIs. A mixed-methods approach was employed. Quantitative data were collected via structured online surveys disseminated to school administrative staff, teachers, students of various age groups, and parents. Qualitative insights were obtained through a series of semi-structured interviews with key stakeholders, providing a multifaceted perspective on implementation challenges and enablers.

A comprehensive review of international and national digitisation practices in education was conducted to identify critical success factors and potential risks associated with Wi-Fi deployment. A representative sample of GSEIs in Kyiv was selected for statistical correlation analysis. The analysis focused on the relationship between access to stable wireless connectivity and average student scores in mathematics and Ukrainian language during the 2024/2025 academic year (September-March period).

To facilitate school participation and ensure a robust sample, the research team engaged educators through thematic online forums and professional communities. In total, 14 institutions were included in the final sample.

Academic performance data were retrieved from the national digital platform “Unified School.” The analysis targeted students in grade 6 (early adaptation phase) and grade 8 (competency consolidation phase). Sampling criteria accounted for technical variables, including internet bandwidth (Mbps), number of wireless access points, ICT infrastructure coverage, and the digital competency levels of teaching staff.

Comparative analysis techniques were used to identify systemic entry points and constraints (“bottlenecks”) in the organization of educational activities under martial law. This analysis was grounded in standardized metrics and consistent data architecture.

In alignment with the PISA assessment framework, the study emphasized student performance in mathematics and reading literacy. Although PISA includes science literacy, science was excluded from this analysis due to inconsistent and limited integration of ICT tools (e.g., virtual laboratories) in science instruction. By contrast, reading and mathematics learning activities were found to benefit from structured ICT usage, including text platforms, interactive exercises, and mathematical simulations.

Figures 10 and 11 present the academic performance of grade 6 students in schools with varying internet bandwidth levels. In institutions with 30-100 Mbps bandwidth, mathematics scores ranged from 5.6 (Lyceum No. 45) to 7.8 (Lyceum No. 234), and Ukrainian language scores ranged from 6.8 to 8.2. The highest performance was observed at Lyceum No. 315, which maintained a 100 Mbps connection and recorded average scores of 8.0 in mathematics and 7.9 in Ukrainian language.

These results suggest a positive association between higher internet bandwidth and improved academic outcomes. Schools with more reliable and faster internet demonstrated higher average performance, implying that access to robust digital infrastructure can enhance instructional quality and learning engagement in secondary education.

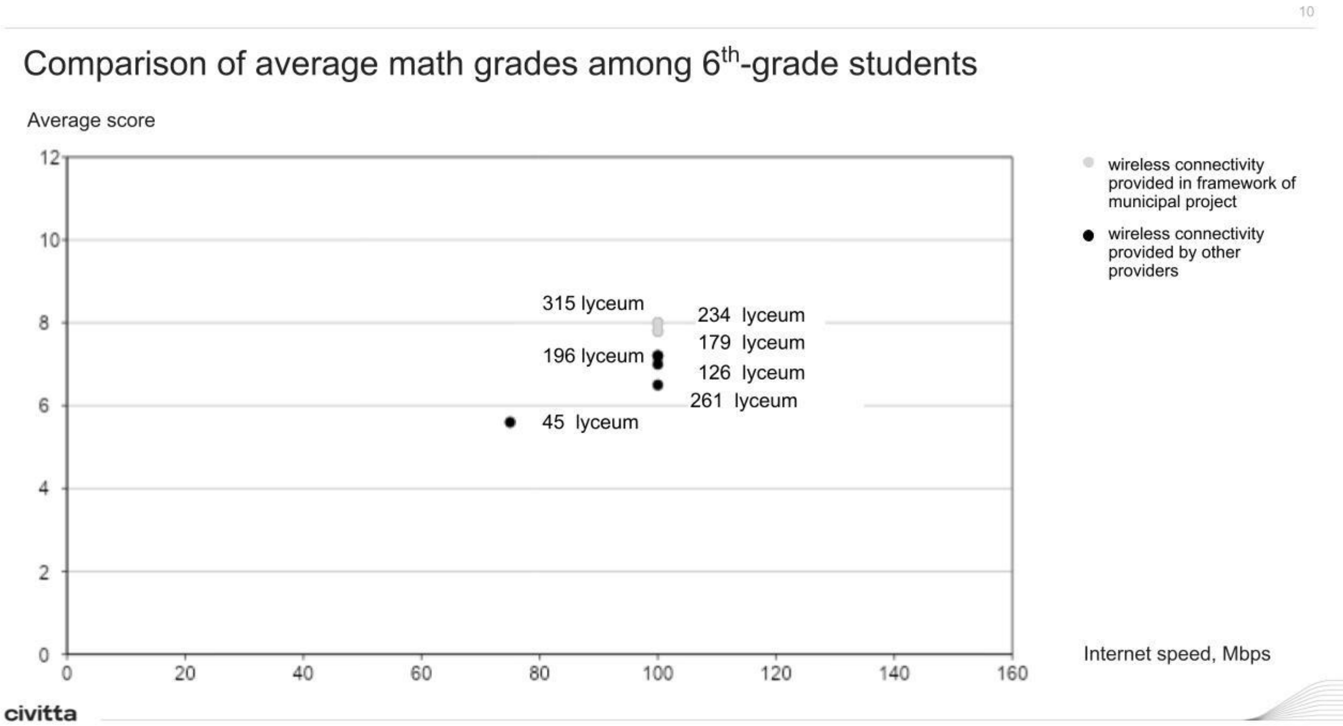


Figure 9 . Comparison of average math grades among 6th-grade students

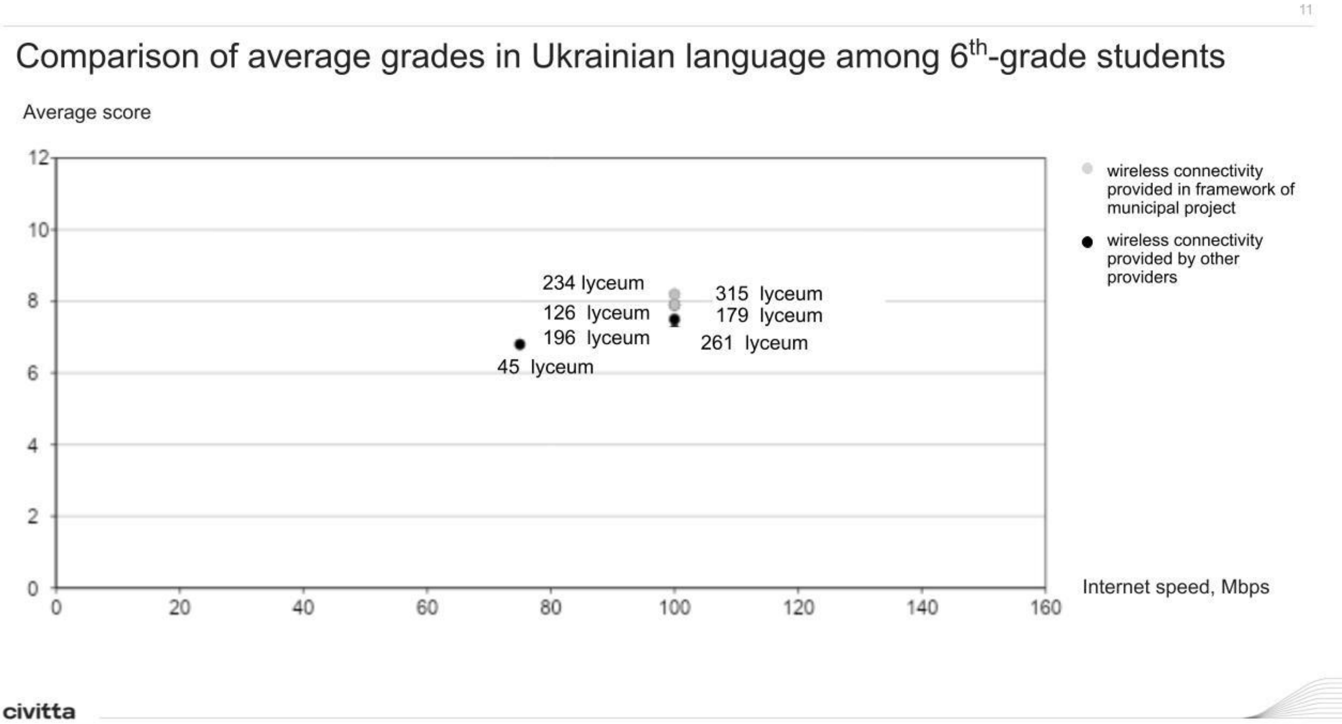


Figure 10 . Comparison of average grades in Ukrainian language among 6 th-grade students

An analysis of the average scores of 8th-grade students in pilot schools with Internet connections of 30-100 Mbps showed that mathematics scores ranged from 6.1 (Lyceum No. 45) to 7.6 (Lyceum No. 179), while Ukrainian language scores ranged from 6.8 (Lyceum No. 234) to 8.3 (Lyceum No. 179). Meanwhile, the institution with a bandwidth of 100 Mbps (Lyceum No. 315) showed average scores of 7.3 in mathematics and 7.5 in Ukrainian language.

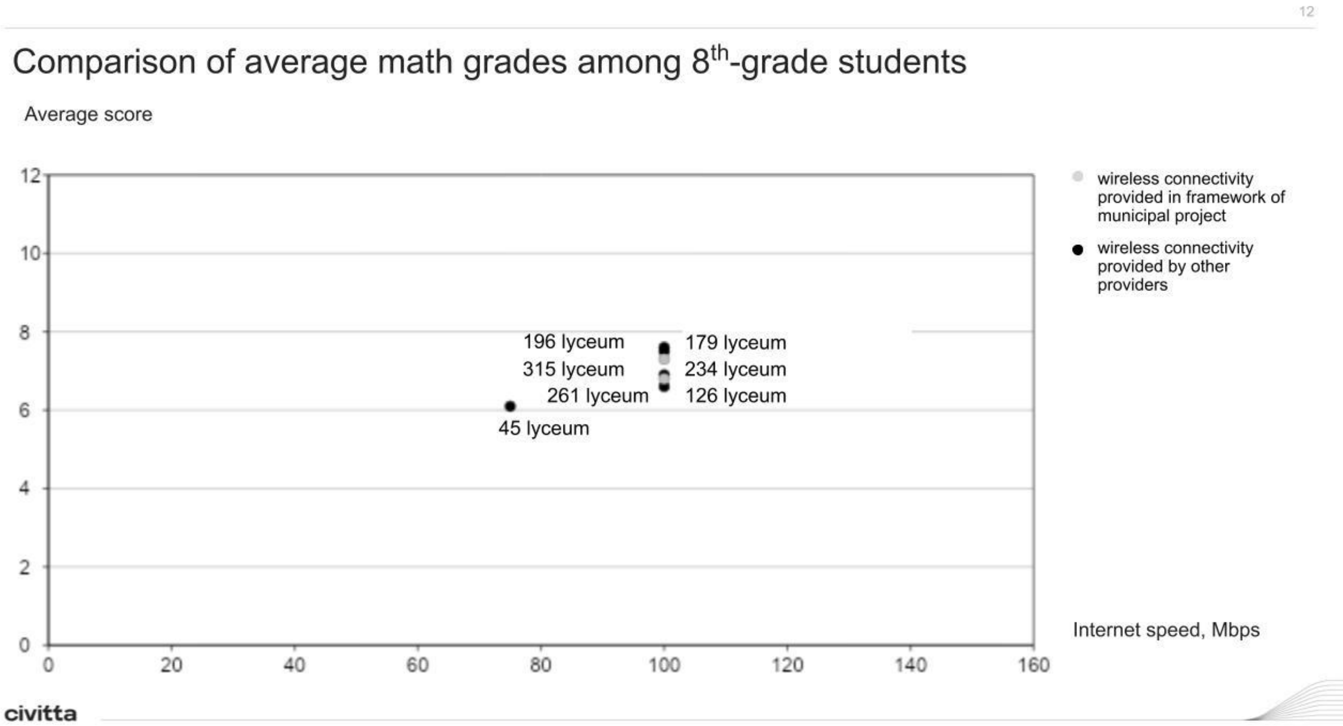


Figure 11 . Comparison of average grades in mathematics among 8 th-grade students

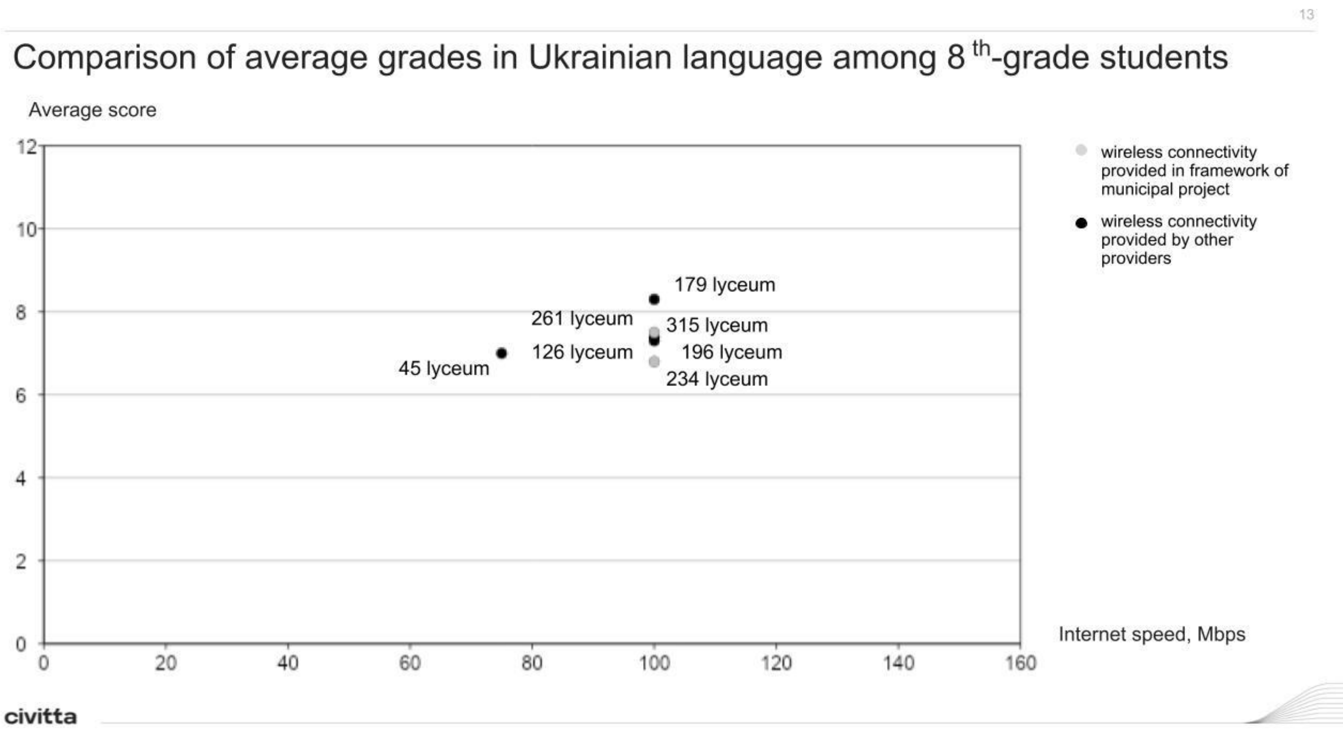


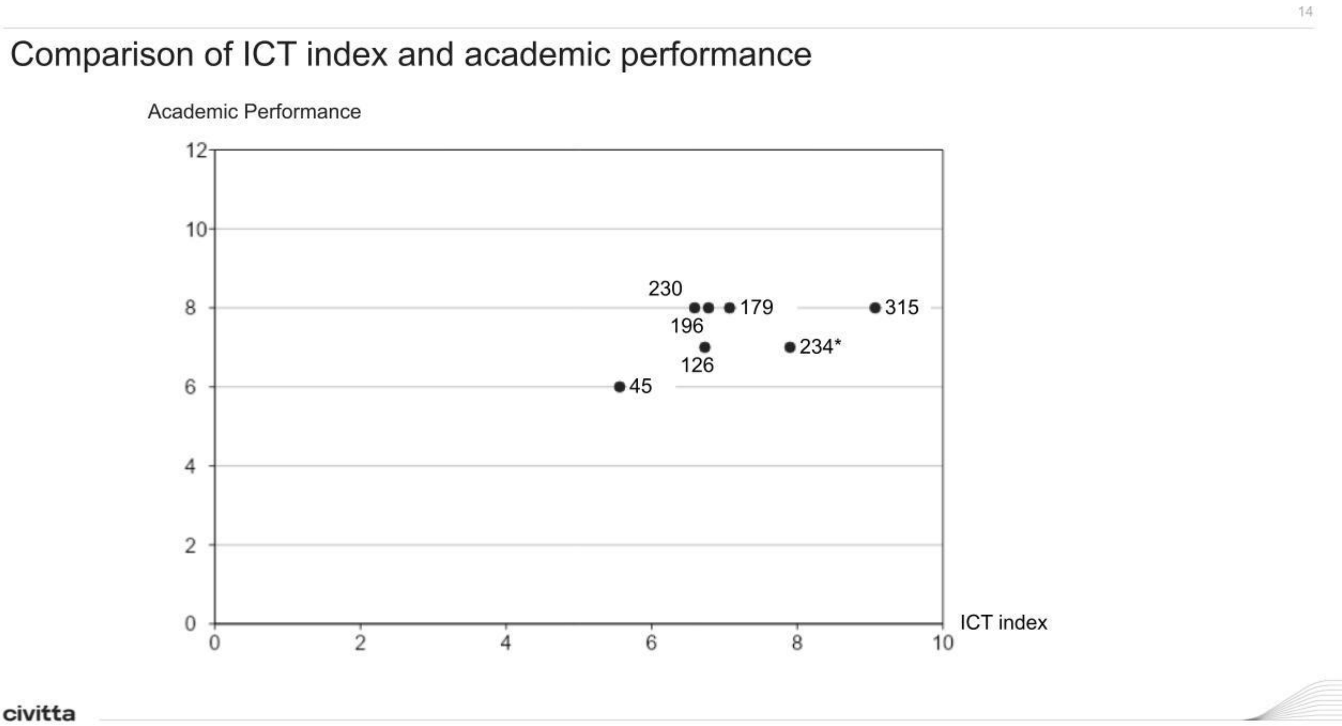
Figure 12 . Comparison of average grades in Ukrainian language among 8 th-grade students

A comparison of academic performance data shows that schools with faster internet speeds demonstrate higher average grades in mathematics and Ukrainian language among students in grades 6 and 8, while schools with slow internet speeds have significantly lower academic performance. This confirms that high-quality and high-speed internet access is an important condition for improving educational outcomes and ensuring equal access to digital learning opportunities. However, schools with internet speeds of 100 Mbps show significant differences in student academic performance, suggesting that there is a critical speed of network access required to ensure a basic level of digital infrastructure, beyond which further increases in bandwidth do not significantly affect academic performance. To finally confirm this hypothesis, extended surveys and in-depth studies (ICT index of all educational institutions in Kyiv) should be conducted, and the graphs obtained (Figures 11-14) should serve as a starting point for planning future pedagogical and technical interventions.

In accordance with international recommendations from the OECD and GEEAP, and based on an analysis of six pilot schools in Kyiv, an assessment scale adapted to the Ukrainian context was developed, consisting of two integrated blocks: digital infrastructure (weighting coefficient 30%) - which takes into account the level of Wi-Fi coverage (average rating 4.2/5), average channel bandwidth (30-100 Mbps, average 58 Mbps), student-to-device ratio (3.5 students/device) and quality of technical support (0.75/1) - and organization of the educational process with ICT (weighting 70%) - covering the frequency and depth of use of digital tools (lessons, knowledge assessment, feedback, average rating 3.8/5), use of adaptive platforms (0.6/1), regularity of ICT training for teachers (4.2 events/year) and digital communication with parents (0.8/1), compared to academic performance (average scores in mathematics and Ukrainian language of 6th and 8th grade students for the 2024-2025 academic year). A scatter plot shows a positive correlation (R^2 = 0.66) between a composite ICT index (0-10) and average academic scores (6.4-7.9) in the pilot lyceums (13). The formula for calculating the Index is provided below.

$$\text{ICT infrastructure} \times 30\% + \text{Educational process} \times 70\% = \text{ICT index}$$

The results obtained indicate the potential positive impact of ICT infrastructure on academic performance and justify the need to expand the pilot project to all secondary schools in the city in order to carry out a full measurement, verify the conclusions, and plan targeted technical and pedagogical interventions.



13 Figure. Dependence of students' academic performance on the ICT index of pilot secondary schools

This suggests that while high-quality internet is important, its impact is mediated by other factors. The data confirmed a statistically significant relationship between the integrated digitalization index and student scores: schools with an index > 7.0 demonstrate an average score ≥ 7.5, while institutions with an index < 6.0 - ≤ 6.8. At the same time, it was found that **high Wi-Fi speeds alone do not guarantee improved performance** without the simultaneous implementation of methodologically sound pedagogical strategies; this is also reflected in the GEEAP's "bad buy" concept, where technical equipment without proper support does not lead to improved academic results. Thus, the key conclusion is the need for a comprehensive approach that includes a standardized technical base, training and support for teachers, and centralized coordination of ICT initiatives to ensure a sustainable positive impact of digital technologies on the educational process.

In addition, the results of in-depth interviews with teachers from pilot secondary schools confirmed significant differences in the degree of implementation of digital tools depending on the level of ICT infrastructure:

- in Lyceum No. 315, digital technologies (Kahoot, Mentimeter, test platforms) are used in 90% of lessons, while teachers note that students are overloaded with visual content and have reduced motivation; at the same time, the school shelter was converted into an autonomous learning space with mobile partitions, basic furniture, and high-speed Wi-Fi (>100 Mbps), ensuring uninterrupted classes for parallel classes during air raid alerts. In the near future, a digital solution will be implemented to inform parents in real time about their children's whereabouts in the shelter, which will increase safety and trust.

- Lyceum No. 234 has a high level of automation through the "Single School" system, Google Classroom, and the Vseosvita platform coexists with low reading literacy among 41% of students nationwide according to PISA-2018 results, which correlates with a lower average score in Ukrainian language (6.8) due to insufficient methodological adaptation of digital resources;
- Lyceum No. 179 systematically uses Zoom, R-book, and Classroom, initiating profile differentiation to overcome fatigue.
- Lyceums No. 196 and No. 126 have a standard level of integration and experience regular Wi-Fi disruptions and limited use of Google Docs.
- Lyceum No. 45 has minimal technical support and actively uses the "Single School" system, the "Vseosvita" platform, and Google Forms.

3.2.1. Staffing and technical support for ICT infrastructure in secondary schools

At the same time, during interviews with the administrations of general secondary education institutions, the need to introduce a centralized system of human resources and technical support for ICT infrastructure in general secondary education institutions was analytically justified. Currently, in accordance with the Model Staffing Table for General Secondary Education Institutions (Order of the Ministry of Education and Science of Ukraine No. 368 of 10.06.2011), there should be one full-time electronics engineer for every 500 students, who is responsible for the organization, technical maintenance, and safe operation of computer equipment, office equipment, and means of communication used in both the educational and administrative processes. The job descriptions of computer science teachers, based on the Law of Ukraine "On Education," the Law of Ukraine "On Labor Protection," the Regulations on the Organization of Labor Protection in Educational Institutions, and relevant local acts, provide not only for conducting lessons in accordance with the curriculum and methodological recommendations, but also ensuring compliance with occupational health and safety and fire safety standards in the classroom, conducting briefings, maintaining electronic documentation (attendance and performance records), participating in final assessments, pedagogical councils and methodological associations, organizing student participation in academic competitions, and interacting with parents. However, there is significant staff turnover in Ukraine: qualified computer science teachers and electronics engineers often move to the IT sector, which leads to the recruitment of non-specialists or teachers with insufficient experience in schools and, as a result, delays in updating equipment, software, and network configuration. During interviews with the administrations of pilot institutions, it was found that about 60% of schools do not have a staff position responsible for the systematic monitoring of ICT resources, which means that technical failures are resolved with a delay of 24 to 72 hours. Thus, to ensure the sustainable functioning of digital infrastructure in GSEIs, it is necessary not only to comply with current staffing standards, but also to introduce centralized monitoring procedures, clearly defined roles for ICT coordinators and system administrators with appropriate salaries and working conditions.

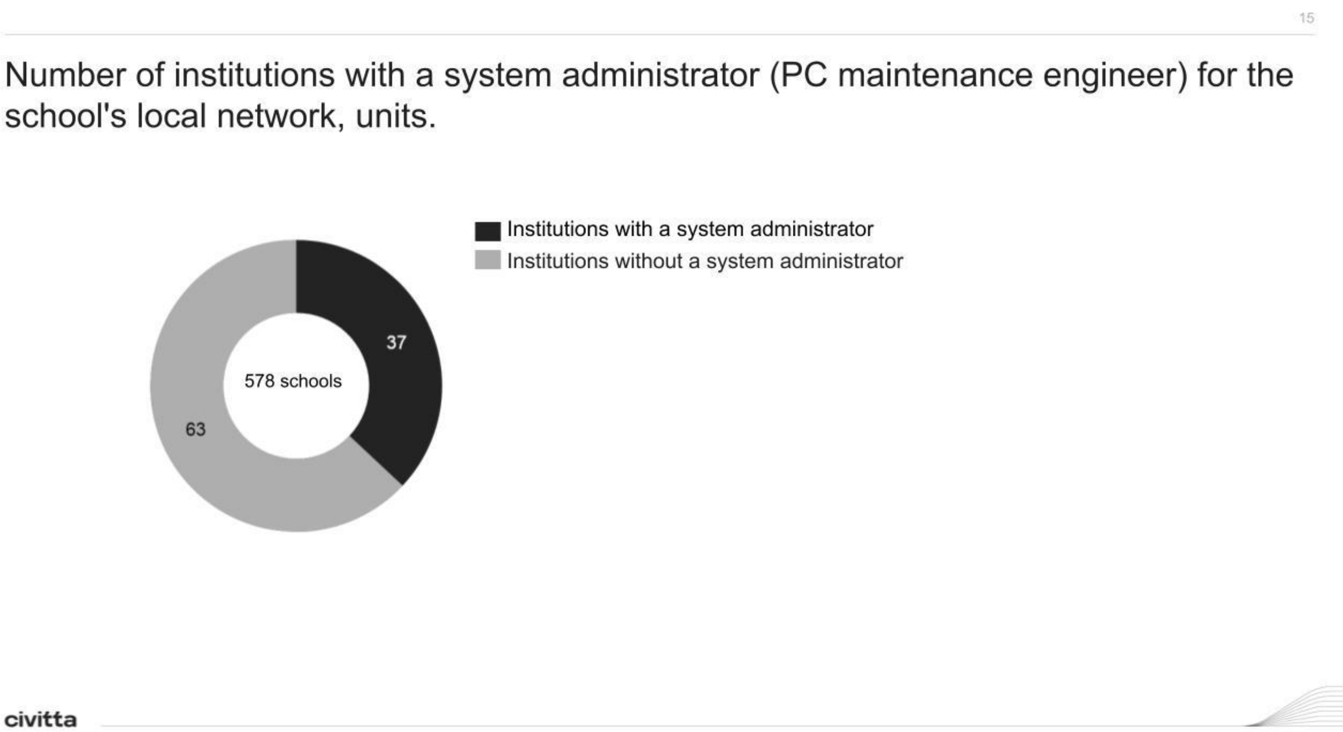


Figure14 . Number of institutions with a system administrator (PC maintenance engineer) for the school's local network, units

Figure14 shows that only 37% of general secondary education institutions in Kyiv (n ≈ 214 out of 578) have a system administrator (PC maintenance engineer) on staff, while in the remaining 63%, these functions are performed by part-time employees or external contractors, which leads to an average technical failure resolution time of over 48 hours and complicates the implementation of innovative IT solutions.

The project team recommends that each school approve a "Digital Infrastructure Development Plan" and appoint an ICT coordinator. This role would involve designing and managing the Wi-Fi network, administering information systems, coordinating technical support and procurement, and organizing training for teachers. The ICT coordinator should have a digital literacy level of at least 4/5 on the DIGCOMP framework.[73] An analysis of the presented results showed that countries with ICT coordinators in schools demonstrate higher average scores in science, mathematics, and reading.

International experience shows that countries with ICT coordinators in schools demonstrate higher average scores in PISA assessments. For example, Estonia which tops the PISA rankings, has integrated ICT coordinators, while Ukraine, without such support, scores significantly lower. Studies in Norway, Australia, and Spain have shown that ICT coordinators reduce technical

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[73] Digital Competence Framework for Citizens (DigComp). https://joint-research-centre.ec.europa.eu/projects-and-activities/education-and-training/digital-transformation-education/digital-competence-framework-citizens-digcomp_en

incidents, improve teacher competence, and increase student engagement and performance.[74,75,76]

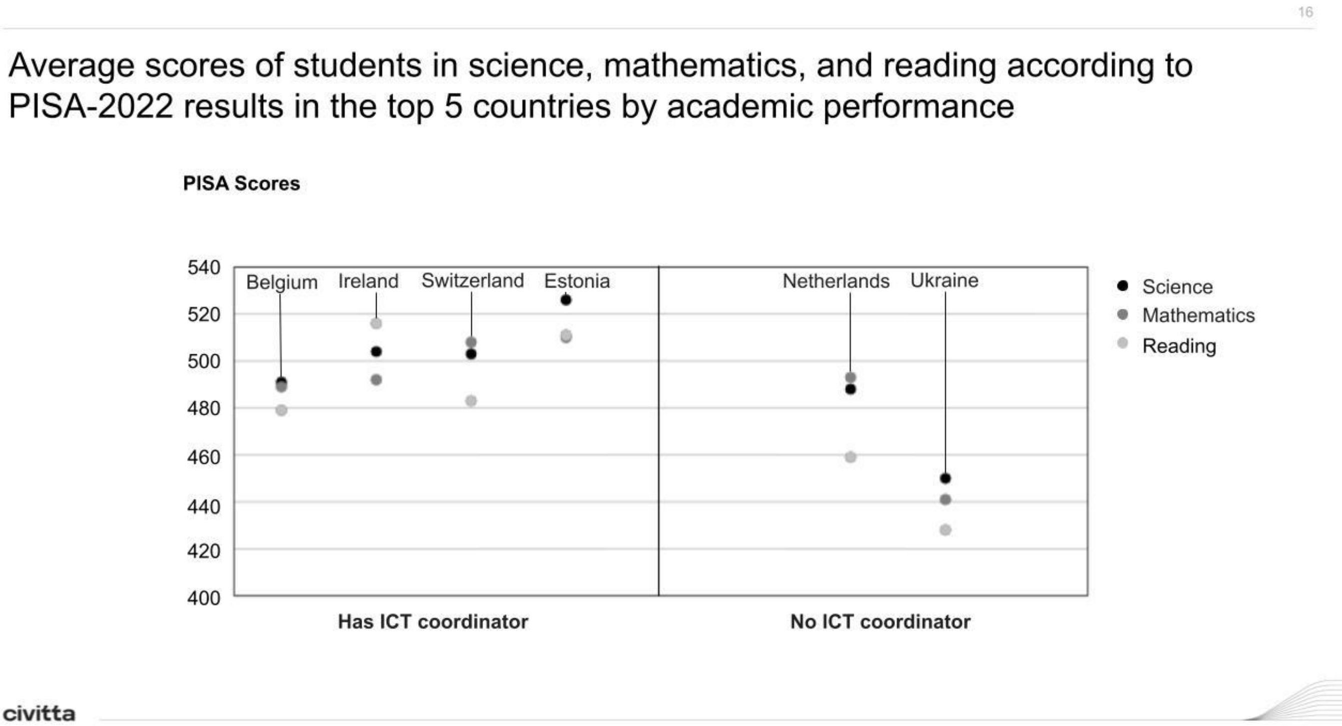

Figure 16. Average scores of students in science, mathematics, and reading according to PISA-2022 results in the top 5 countries by academic performance

Considering international experience, in particular the positive results of PISA-2022[77] in countries with ICT coordinators, and given the lack of systematic technical and methodological support in Ukrainian schools, it is advisable to integrate the position of ICT coordinator into the staff of general secondary education institutions. Given this evidence, it is advisable to integrate the position of ICT coordinator into the staff of Ukrainian GSEIs. We propose creating a network of Centers of Excellence to pilot new technologies and provide expert support.[78,79]

This would create a platform for systemic digital change and bring Ukrainian schools closer to international standards.

As part of the digital transformation of GSEIs, the position of ICT coordinator combines three complementary functional areas:

[74] Taylor & Francis Online. 2024. The changing role of ICT coordinators in schools: a longitudinal study. https://www.tandfonline.com/doi/full/10.1080/02619768.2024.2406893#abstract

[75] Wiley Online Library. 2012. The role of e-learning coaches in Australian secondary schools. https://onlinelibrary.wiley.com/doi/10.1111/j.1365-2729.2012.00488.x

[76] Bera. 2019. Building the role of ICT coordinators in primary schools: A typology based on task prioritisation. https://bera-journals.onlinelibrary.wiley.com/doi/abs/10.1111/bjet.12888?

[77] See Appendix A (Appendix 10)

[78] Centre for Excellence. About Us. https://www.cee.org/about-us/about-us

[79] 1EdTech. 2025. Centers of Excellence Program. https://www.1edtech.org/coe

- **planner** (development of ICT projects in schools, management of internal networks and the school website, development of digital development strategies);
- **educator** (training support for teachers, advice on the use of online resources, encouraging the creation and dissemination of ICT content among teachers);
- **technician** (technical support for users, maintenance of ICT equipment, administration of digital platforms and accounts).

Within the pilot project, the project team recommends introducing one ICT coordinator position for three to five schools in one educational district to test the ICT coordinator's workload, develop standard operating procedures, and assess the impact on the speed of technical malfunction resolution, the level of digital competence of teachers (based on the DIGCOMP framework), and the academic performance of students. Research on international experience in this area shows that in the modern education system, the position of ICT coordinator is a necessary component of digital transformation: it combines technical support, methodological guidance, and organizational and strategic management of ICT implementation.

Report Conclusions

Based on a mixed-methodology approach combining quantitative analysis and in-depth interviews, this study identified several systemic challenges hindering the effectiveness of digitalization in pilot secondary schools:

- **Screen fatigue** - 78% of teachers surveyed described student screen fatigue as "significant," resulting from excessive visual content and long online sessions.
- **Uneven digital competence** - teachers' self-assessed digital competence ranged from 2.1 to 4.8 on a five-point scale, leading to inconsistent implementation of ICT in the learning process.
- **Lack of centralized support** - none of the pilot institutions had an ICT coordinator on staff, and all system administrators worked part-time, leading to an average technical issue resolution time of 48 hours.

In the current environment, schools require uninterrupted Wi-Fi access not only for daily lessons but also for emergencies, enabling the use of digital platforms for everything from instruction to communication with parents. However, socio-economic factors continue to influence academic achievement, highlighting the need to reduce the digital divide.

To achieve uniform and high-quality results, it is necessary to combine the development of ICT infrastructure with the improvement of digital competencies for both teachers and students, alongside providing robust methodological support at all stages of the educational process.

Report recommendations

Develop and implement standardized templates for questionnaires, surveys, and checklists for all pilot GSEIs to unify data collection and ensure the comparability of information.

Expand the representative sample to include GSEIs from different administrative and territorial regions of Ukraine in subsequent studies to confirm the identified correlations between ICT infrastructure and academic performance.

Introduce and monitor educational models for Wi-Fi integration in pilot schools, tracking their impact on average grades in mathematics and Ukrainian language for at least one full academic year.

Organize systematic training to improve teachers' digital literacy and develop detailed methodological recommendations for conducting interactive lessons using ICT, in accordance with the DIGCOMP framework.

Establish mechanisms for continuous monitoring and evaluation of Wi-Fi network effectiveness and digital service use, involving administrators, ICT coordinators, teachers, and parents to identify problems and make timely adjustments.

Create a network for the exchange of best practices, bringing together schools on specialized online platforms and forums to share lesson plans, technical solutions, and case studies.

Introduce the position of ICT coordinator in every secondary education institution, responsible for developing and implementing a digital infrastructure plan, providing methodological support for teachers, and coordinating with Centers of Excellence to ensure systematic support for digitalization.

Appendices A

Appendix 1	Results of a monitoring study (review) of the readiness of preschool, general secondary, and extracurricular education institutions for the 2024/2025 academic year
Appendix 2	Report on the results of the nationwide monitoring study of the quality of education in general secondary education institutions under martial law
Appendix 3	Answers provided by 6th grade students, disaggregated by subject from educational institutions
Appendix 4	Answers provided by 8th grade students, disaggregated by subject, from educational institutions
Appendix 5	Information on the material and technical base and IT support of general secondary education institutions (excluding special institutions) of state and private ownership (2024/2025 academic year)
Appendix 6	PISA Report 2018(8)
Appendix 7	PISA Report 2018(9)
Appendix 8	PISA Report 2018 (10)
Appendix 9	Questions for in-depth interviews
Appendix 10	PISA Report 2022
Appendix 11	PISA Report 2018 full version
Appendix 12	National report on the results of the international study on the quality of education PISA-2022

Appendix B

Graphic content

Question the answer