

Information technologies in IT education as a factor of digitalization of Ukrainian society*

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Abstract

The article investigates the digitization of Ukrainian society, the role of digital skills in labor market demand, digital literacy among the population, and the key audience of educators - teenagers. It outlines the approaches and experiences of the Department of Information Technology and Computer Engineering at Dnipro University of Technology in transforming IT education. It specifically examines the teaching of programming courses to first-year students to build foundational competencies for continued learning and the use of digital technologies in training specialists for government bodies. The article also highlights the integration of Cisco International Network Academy courses into the curriculum and the training of specialists through educational partnership projects with businesses.

Keywords

IT education, Cisco International Network Academy, Digital transformation of education, public administration specialists' education

1. Introduction

Digitalization is an integral part of modern society. Every year, the DataReportal service, together with the creative agency "We Are Social" and the media analytics platform Meltwater, publishes an annual report on news and trends in the digital space. According to a recent report, at the beginning of 2024, more than 69% of the 8.08 billion inhabitants of the Earth use mobile phones (5.61 billion people), 66.2% (5.35 billion people) of the world's population have access to the Internet, 62.3% use social networks [1]. While the growth of the size of global networks slowed down (+7.2% in 2020, +2% in 2021, +1.9% in 2022, +1.8% in 2023), more people use digital technologies and spend more time online.

Digitization changes the workforce. According to the estimates of "Transforming our World: the 2030 Agenda for Sustainable Development" from the UN [2], more than 2 million new high-tech jobs will appear by 2030, and about 90% of jobs will require digital skills.

All changes that occur in society are reflected in the educational process. Traditional education combined with modern information technologies is the need of the hour. The use of modern technologies in education currently plays an important role in creating the necessary conditions for the self-development of student youth, the activation of creative abilities, and the formation of necessary competencies.


One of the components of the digitalization of education is creating a modern educational environment, in particular, multifunctional flexible spaces that facilitate various forms of work and motivate learning. The modern educational space is based on two principles – flexibility and stability. Flexible organization allows you to quickly change the space depending on the needs of the educational process and implement various forms of work. Stability ensures the continuity of the

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process, the consistency of perception and activity, and the maintenance of order in space and manageability in work.

2. Statement of the problem

The progress towards quality of digital education was perceived as less than optimal before the COVID-19 pandemic, which has devastated education, causing a loss of knowledge in four out of five of the 104 countries surveyed. As the fourth sustainable development goal out of 17 identified, the UN indicates quality education, which is the key to achieving many other sustainable development goals. Among the directions for achieving this goal, the need for such measures as free and compulsory education, increasing the number of teachers, improving the basic school infrastructure and applying the digital transformation of education [3] is indicated.

Michael Fullan, a well-known Canadian educator and expert in the field of education, describes the importance of introducing digital technologies into the educational process as a transition from traditional to digital learning [4]. According to his views, digital technologies can help create interactive learning environments that ensure the active participation of learners in the learning process. He believes digital technologies can help provide personalized learning, allowing each learner to focus on their needs and interests. According to Fullan, introducing digital technologies into the educational process requires changes in approaches to learning and the organization of the educational process, emphasizing that teachers must have the necessary knowledge and skills to use digital technologies to effectively implement them in their work.

A digital transformation of education is necessary to achieve new educational results that meet the requirements of a digital society. This transformation aims to improve the quality and accessibility of education and also requires new skills and knowledge from participants in the educational process [5-10].

Using new technological tools and unlimited information resources, the education system must learn to implement them effectively in the educational process. The practice of online courses and mixed learning creates a field of limitless educational opportunities that focuses on the quality of education for each person, regardless of place of residence and skills, but according to his interests and capabilities [11-14].

The importance of introducing digital technologies into the educational process at various levels of education is reflected in the works of modern teachers and researchers from all over the world [15-18], including Ukrainian ones [19-20].

3. Digital transformation of Ukrainian society and the level of digital literacy of the population

Despite the war, Ukraine is confidently moving toward the digital transformation of society. Regional digital transformation remains a constant priority for the Ministry of Digital Transformation of Ukraine. After all, regional digitalization, especially at times of war, is necessary to provide high-quality medical, educational, social, administrative, and other public services and to ensure access to cellular communication and stable Internet, as well as to improve the level of cyber security and the functioning of critical infrastructure in general.

Regions and communities are key players in the development of European integration because they stimulate the introduction of digital technological changes and form a new decade of digital Ukraine, which makes it competitive in the international arena [21].

The goals of the Ministry of Digital Transformation are:

- Digital literacy
- Public services online
- Access to high-speed Internet

- Digital Economy

In 2022, the Regional Digitization Team of the Ministry of Digital Affairs of Ukraine developed a tool for measuring the processes of informatization and digitization in 24 regions of the country – the Index of Digital Transformation of the Regions of Ukraine [22]. The Index contains 8 main blocks: institutional capacity, development of the Internet, development of Center for the Provision of Administrative Services, "paperless" regime, digital education, business card of the region, prevalence of basic electronic services, and industry digital transformation. Institutional capacity means the presence of a digital leader. This developed and approved informatization program provides financing for activities in the field of digital transformation, as well as a structural unit for digital development in government bodies. These priority steps make it possible to qualitatively and quickly implement national digitization programs at the regional and local levels.

In 2022, the Index within Ukraine was 0.650 points out of 1 possible. Dnipropetrovsk (0.916), Ternopil (0.910) and Odesa (0.836) regions had the highest value of the Index. The following year, the Index included new measures to assess the work of deputy heads of regional military administrations on issues of digital development, digital transformations, and digitalization such as health care, civil safety, and accessibility in the provision of administrative services. The indicator for Ukraine was 0.632, with Dnipropetrovsk (0.908), Lviv (0.891) and Poltava (0.833) regions leading the way in 2023 [21]. Within sub-indices, only three subjects with an institutional capacity equal to 1 – Dnipropetrovsk Region (0.968) scored higher (0,968) than Ternopil Region (0.732) and Odesa Region (0.620) in Digital Education but had a second position in terms of Internet development Ternopil (0.916), Dnipropetrovsk (0.902), Odesa (0.849).

When we talk about the digitalization of any component of life in modern society, including education, it is worth paying attention to digital inequality. On the one hand, there is a growth of opportunities, but on the other hand, there is an increased digital divide. In Ukraine, where the digital transformation is moving very quickly, the issue of the digital divide and the possession of digital skills also remains acute but tends to improve.

Mykhailo Fedorov (Vice Prime Minister for Innovation, Development of Education, Science and Technology, Minister of Digital Transformation), during the presentation of the results of the national sociological survey of digital literacy for 2023, reported that 93% of the adult population of Ukraine aged 18–70 have digital skills years (+8% from 2019, +4% from 2021); 95% of teenagers aged 10–17; 99% of people with hearing impairment are 18-59 years old (+15% in 4 years) [23]. The share of adult citizens with basic digital skills in Ukraine is currently 59.6%. Over four years, it grew by 12.6%. 38% of citizens possess digital skills at a high level. Such a study was conducted for the first time in 2019 and for the second time in 2021.

The results of the 2023 study show that among the vacancies requiring digital skills, the highest demand is for advanced digital skills (Above Skills) - 36.3%; for example, cloud technology or software development, artificial intelligence, etc. For Ukrainian society, this is important from the standpoint of economic development and recovery because advanced digital skills increase the gross domestic product (GDP) most powerfully due to the increase in workers' income, as well as their innovation and productivity in the workplace.

Workers with digital skills earn 81.3% higher wages than those without digital skills. The presence of advanced digital skills affects the level of satisfaction with professional life by an average of 17-29% compared to those who have not mastered digital skills. Two thirds (68.5%) of respondents with Above Basic Skills answered that they achieved their defined professional goals, while only 40.0% of respondents with No Skills level agreed with this statement (a difference of 28.5%).

The average salary for digital skills is €1,130.9 as of October 2023. Advanced digital skills add €110.8 billion to Ukraine's annual GDP. The income gap per month between "digital and non-digital" workers is the largest in Central Ukraine (€570) – which is almost twice as low as the most developed macro-regions: the West (€1004) and the South (€1004).

Educators are particularly interested in digital literacy for the target audience of teenagers (10-17 years old). Table 1 shows a comparison of teenagers to adults. Compared to the adult population, a

former group reports a higher and increasing level of digital skills above basic ("basic" + "above basic skills"). In 2019, the 'basic' or 'above basic' category accounted for 86% of respondents, in 2023 – 88%. At the same time, the share of teenagers with basic skills decreases, and the share of those with the above basic skills increases (Table 2).

Table 1

Digital skills index of 2023 by target groups and areas of competence by the level of "basic" and "above basic skills"

Target group	The sphere of digital competencies (%)			
	Information skills	Communication skills	Skills for solving life problems	Digital content creation skills
Adult population	91	91	86	60
Teenagers	93	95	94	60
People with hearing impairment	96	98	94	63

Table 2

Dynamics of digital skills of teenagers in terms of areas of competence (%)

	2019	2021	2023
<i>Information skills</i>			
No skills	7,3	4,9	7,2
Basic skills	16,6	16,8	7,2
Above basic skills	76,1	78,3	85,6
Total	100	100	100
<i>Communication skills</i>			
No skills	7,3	6,8	5,0
Basic skills	6,5	4,4	1,7
Above basic skills	86,2	88,8	93,3
Total	100	100	100
<i>Skills for solving life problems</i>			
No skills	0	1,5	5,7
Basic skills	11,7	18,0	11,4
Above basic skills	88,3	80,5	82,8
Total	100	100	100
<i>Digital content creation skills</i>			
No skills	7,3	11,5	11,7
Basic skills	6,5	11,5	9,7
Above basic skills	86,2	77	78,6
Total	100	100	100

Despite the pandemic and war, increased digitization of the school educational space may inform teaching approaches in higher education. The subsequent sections highlight methods for digitalizing the educational process of higher schools, using the example of the Department of Information Technology and Computer Engineering (ITCE) at Dnipro University of Technology (DUT).

4. Experience of department teachers

When teaching first-year students 12th field of study Information technologies of basic disciplines, in particular, Algorithms and data structures and object-oriented programming, it is important to form basic skills and competencies that become the basis for further successful mastering of the IT speciality, such as

- Be able to design, build and implement basic algorithms for processing various digital data when creating the latest information technologies in the structure of information systems.
- Be able to design and implement appropriate digital data processing algorithms using modern programming languages.
- To be able to formalize algorithmic solutions at all stages of collection, transmission and processing of digital data in the structure of information systems and relevant technologies.
- Have basic knowledge of the basic provisions of object-oriented programming, the definition and content of the basic concepts "Encapsulation", "Inheritance", "Polymorphism", as well as the principles of organizing the interaction of objects.
- Know the means of presenting data in simple (basic) and complex (derived) types and methods of object-oriented programming in modern integrated program development environments.
- Be able to implement prototypes of software architecture, effectively conduct administration, and automate the processes of creating software products.
- Be able to develop a hierarchy of classes and objects and create template classes.

However, mastery of programming was greatly improved with electronic notes of lectures, which contained program codes, block diagrams of algorithms, reference material and were provided to students in advance. Its use freed up much additional time by minimizing the information students needed to take in their own notes. This approach feeds attention to explanations and allows one to familiarize oneself with many examples that illustrate theoretical aspects. With the introduction of electronic teaching aids, it became possible to reinforce lectures with presentations and to demonstrate how program code works directly in the development environment. However, there are also challenges. When lecturing to a large audience, good practice dictates that the "last row effect" be considered so that the program's text is readable to all. When the font size is quite large, it is impossible to display the full text of even a small structured program designed according to the "rules of good tone" on the screen. Showing only a fragment of the code does not allow students to perceive the solution to the problem as a whole.

Most recently, distance learning allowed programming teaching on a new methodological level – using digital solutions that became an educational standard in DUT, such as Microsoft Office 365 and the distance platform Moodle (Figure 1).

Immediately after enrollment, all students receive a single account for the university's educational resources. All educational materials (work program, syllabus, lecture notes, practical and laboratory work tasks, literature, and materials for independent work) are posted in advance on the course page in Moodle. Also, in Moodle, educators can create a bank of questions on the subject to test students' knowledge. This is very convenient when the teacher has several student groups taking the course in the same discipline, as well as for repeated use in the future. The bank of questions can be updated and modified as needed for the course. Students enroll in the course through self-registration (of note, teachers can also enroll students). In Teams, a team is created for the whole group of students to conduct lectures and lab/practical sessions. If assistants are involved in the learning process, they are also added to the Teams team and the Moodle platform as assistants. In Teams, at the beginning of the semester, tasks are created for lab/practical classes with an indication of requirements, deadlines and the maximum number of points for completing the tasks, which are determined by the work program of the discipline. Collaborative work in a single team improves communication among

its participants and allows assistants to have access to lecture recordings if necessary. The lecturer can see the progress of various reports and corresponding student evaluations in real-time and can assess presence during lectures and lab/practical classes.

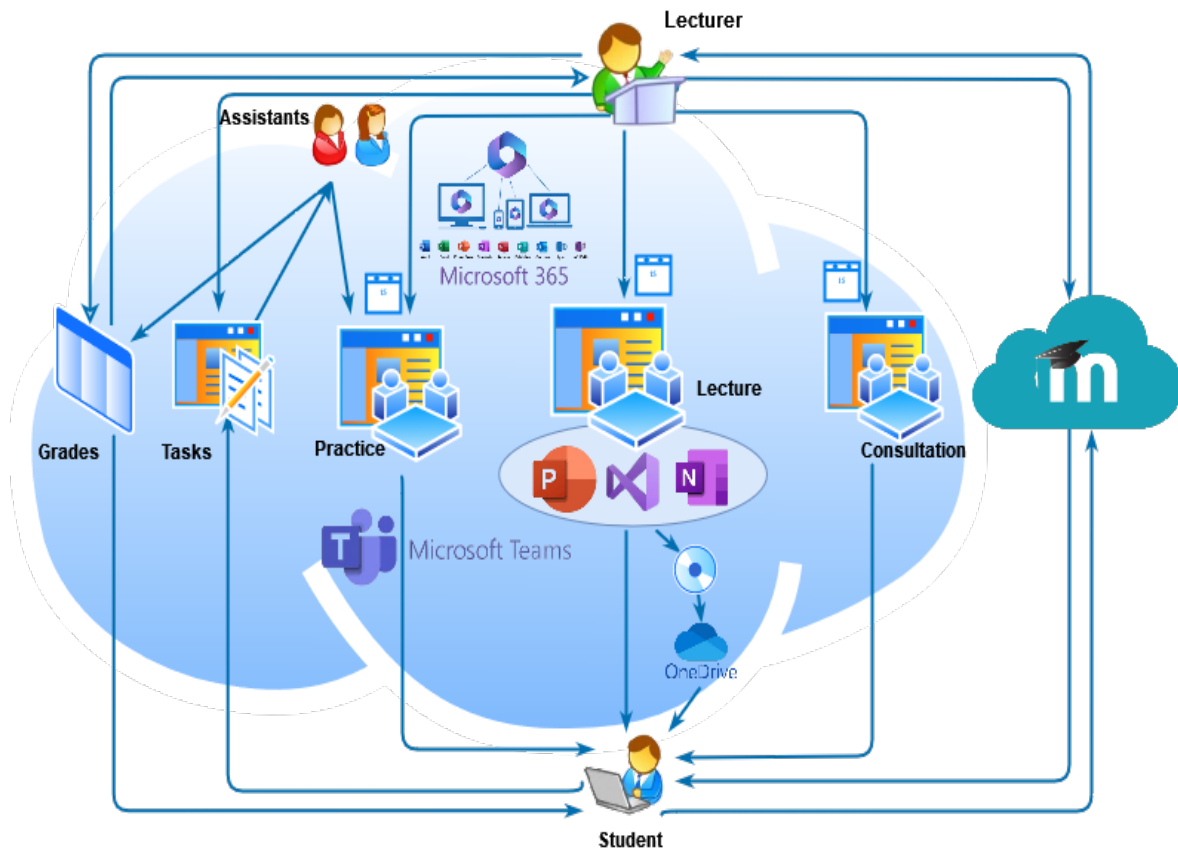


Figure 1: The life cycle of programming disciplines in a digital learning space.

Recording is necessary for distance / mixed learning when conducting lectures. Video recording is stored in the OneDrive cloud storage and is available for download and viewing at any time. To optimize cloud storage, recordings are stored for a certain time (90 days by default), and the lecturer has the opportunity to adjust the storage period of the recording. The lecture must be illustrated by a presentation demonstration with a reference outline of the lectures in the PowerPoint program. When studying difficult-to-understand topics (for example, dynamic data structures, class development, etc.), the lecture is supplemented by writing the code in Microsoft Visual Studio, DevC++ or Visual Code development environment, depending on the programming language, and by demonstrating results of the program, typical errors and their debugging. Program codes developed during the lectures for further independent processing are added to the team library in Teams, to the team notebook using OneNotes application. The common space of OneNotes is also used in the interactive format of lectures and lab/practical classes when the teacher sets a problem, provides instructions/hints for its solution and allows students to solve it independently by joint efforts. The convenience of the common space of OneNotes is that all students have access to it in real-time, see all changes on the screen and actively participate in interactive work.

In the conditions of distance and mixed learning, it is important not to lose the connection between the student and the teacher, and to provide students with a comfortable learning environment. Office 365 also helps in establishing communications. In Teams, when checking tasks, the teacher can write comments and return the work for revision. When learning programming,

students often cannot independently fix even elementary bugs in code. Teams allow the educator, in addition to sharing your screen for demos, to give remote access to user computers. This is very helpful in correcting errors in the code and explaining the errors found to all students. Sensitive nature should be respected when interacting with students in this way. Teachers should remember the peculiarities of the psychology of teenagers, their vulnerability, and self-doubt, and ask for permission to publicly correct mistakes. However, this type of work is very appropriate during individual consultation, where the student's privacy is respected.

Such methods of digitalization of teaching are also used for teaching subjects in senior courses. They have been successfully developed in a mixed and distance form of learning and can be used in a face-to-face format, given that access to all resources can be obtained from a smartphone.

The war increased digital inequality in education due to limited access to the Internet and mass blackouts due to the destruction of Ukraine's energy system by the aggressor country. Students living in rural areas sometimes do not have the opportunity to receive educational services for several days in a row due to the lack of electricity. To provide uninterrupted access, the educational resources of DUT were gradually transferred to the cloud during the winter of 2022-2023. Placing materials for distance learning on the Moodle platform and mandatory recording of lectures during classes on the Teams platform allow students to fully master academic disciplines in compliance with all safety standards at convenient time and when there is light and access to the Internet.

International experience in providing digital educational services is also integrated into the educational process at the ITCE Department.

Since 2005, the Dnipro University of Technology has been operating the Cisco Network Academy (chaired by professor of the ITCE Department Leonid Tsvirkun), which in 2023 received Premier+ partner status at a conference in Paris.

The Cisco Network Academy has been working in the world since 1997 under the slogan [24]: "World changers aren't born. They are made. As the world changes all around us, acquiring technical skills is what brings opportunity, and the promise of education is what offers hope. Who will teach and nurture these world changers of tomorrow, these global problem solvers? We will. Together with our education, instructor, training and employment partners, we're committed to developing the future workforce. Join us as we change the world – one student at a time." The Cisco company began to cooperate with specialists in the field of education and initiated a program to create and maintain easy-to-use and economical computer networks for educational institutions. Educators needed appropriate knowledge and skills to maintain and develop their networks. In response to these needs, the company launched training activities for employees of educational institutions, developing advanced training courses for them, which were quite successful. Today, it is a community of students, teachers, employers, non-governmental organizations, Cisco employees and customers:

- 20,5 million students;
- 29,700 teachers worldwide,
- 11,700 organizations offering courses in 190 countries.

Based on a survey, 95% of students who completed courses for Cisco Advanced Certification obtained a job or continued education between 2005 to 2022. The Academy's contribution to education over the years (equipment, materials, and support for students, schools, and instructors) is estimated at \$4.8 billion. In 2022, celebrating its 25th anniversary, the Academy set a goal "to provide digital skills training to 25 million more people over the next 10 years" [24].

In Ukraine, the Cisco network academies program began in 1999, and now more than 150 network academies at schools, academies and universities significantly contribute to solving the problem of the lack of qualified personnel with knowledge of information technologies. The Cisco Networking Academy program provides students with a comprehensive learning environment that allows them to learn anytime, anywhere, independently or with the support of an instructor, on real laboratory equipment or in special emulator programs, namely:

- registration and remote access system;
- online access to interactive learning materials presented in the form of text, video and audio presentations, animation resources, laboratory tasks, and self-test questions that meet a variety of student needs and teaching methods;
- performance of practical tasks on high-quality Cisco network equipment in laboratory conditions as close as possible to the environments of network installation and maintenance;
- real-time testing, remote access to test tasks at any convenient time and in any place;
- personalized feedback that provides students and teachers with information about the level of knowledge and skills of each specific student, work on errors;
- uninterrupted authorized access to own personal data and test results throughout the entire study period.

At ITCE Department, the implementation of Academy courses in educational disciplines is not only for graduation specialities of the Department but also for specialities of all 12th fields of study, namely (Fig.2):

- Information protection in computer networks (Cybersecurity Essentials course).
- Administration and scaling of corporate networks (CCNA: Enterprise Networking, Security, and Automation).
- Computer networks (CCNA: Introduction to Networks, CCNA: Switching, Routing, and Wireless Essentials).
- Information and switching technologies of the Internet of Things (IoT Fundamentals: Connecting Things).
- Operating Systems (NDG Linux Essentials).
- Programming computer systems in Python (PCAP: Programming Essentials In Python).
- Programming (CPA: Programming Essentials in C++).
- Cloud technologies (IoT Fundamentals: Big Data & Analytics).

performed by certified instructors, professors, associate professors, and assistants of the Department.

Also, the Center for Training Instructors and Support for Cisco Academies at Dnipro University of Technology offers training courses for instructors in a wide range of directions, from the basics of information technology and basic courses on networks to specialized courses on computer system security, programming basics (C/C+, Python, Javaskirt, Java) and the use of Unix-like operating systems, the Internet of Things with obtaining internationally recognized professional certificates recognized. The center provides access to multimedia online courses, online testing tools, laboratory classes on network equipment, as well as consultations and teacher support.

For the third year in a row, specialists of Dnipro University of Technology are teachers of Open Agro University from the company Kernel – the largest producer and exporter of grains in Ukraine, the leader of the world market of sunflower oil, a key supplier of agricultural products from the Black Sea basin region to world markets. The company accounts for about 8% of the world's sunflower oil exports. Kernel supplies its products to more than 70 countries. Since November 2007, the company's shares have been traded on the Warsaw Stock Exchange (WSE).

Educational projects for students at Kernel reveal the potential of beginners and form specialists of a new generation. Open Agro University is a unique educational project for training specialists of the new generation in the agricultural and food industry for students of 3-5 years of specialized specialities or graduates of the last 3 years. The project's experts are more than 100 speakers from the coolest specialized companies, teachers from key educational institutions of Ukraine, global manufacturers of agricultural machinery, plant protection products and fertilizers, and international experts – industry specialists with unique expertise.

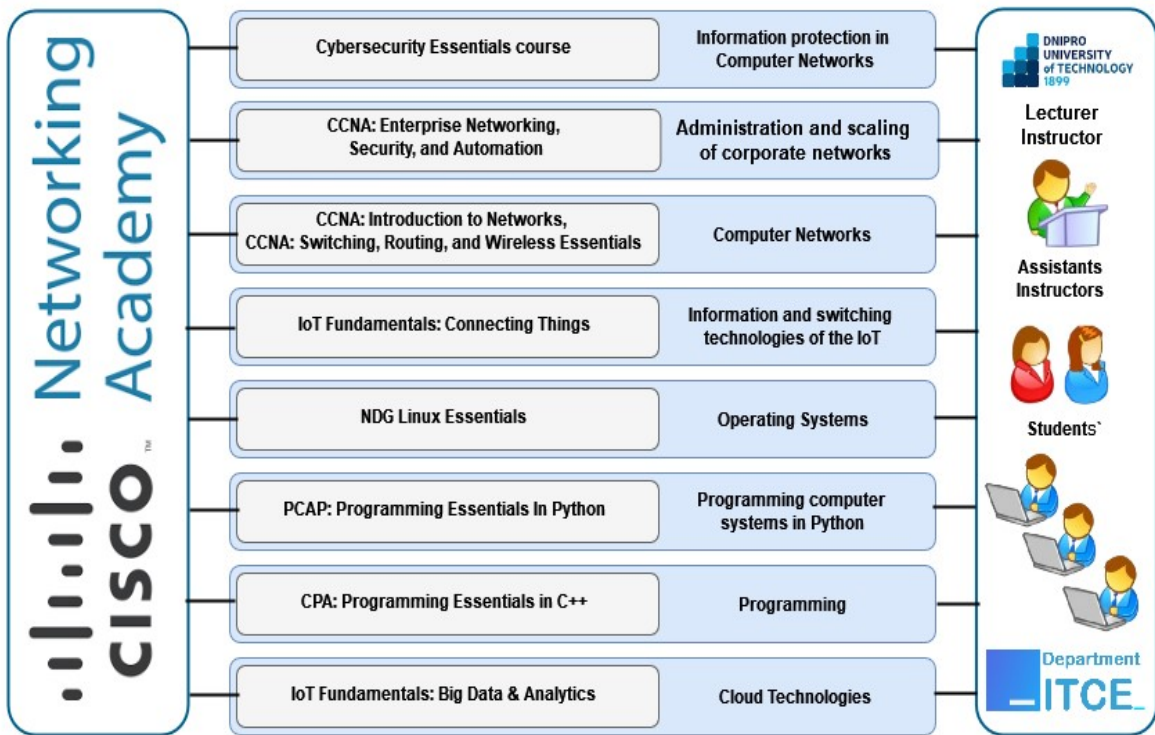


Figure 2: Implementation of Cisco courses in the educational process of the Department ITCE (CCNA – Cisco Certified Network Associate; NDG – Network Development Group; PCAP – Certified Associate Python Programmer; CPA – Certified Associate Programmer).

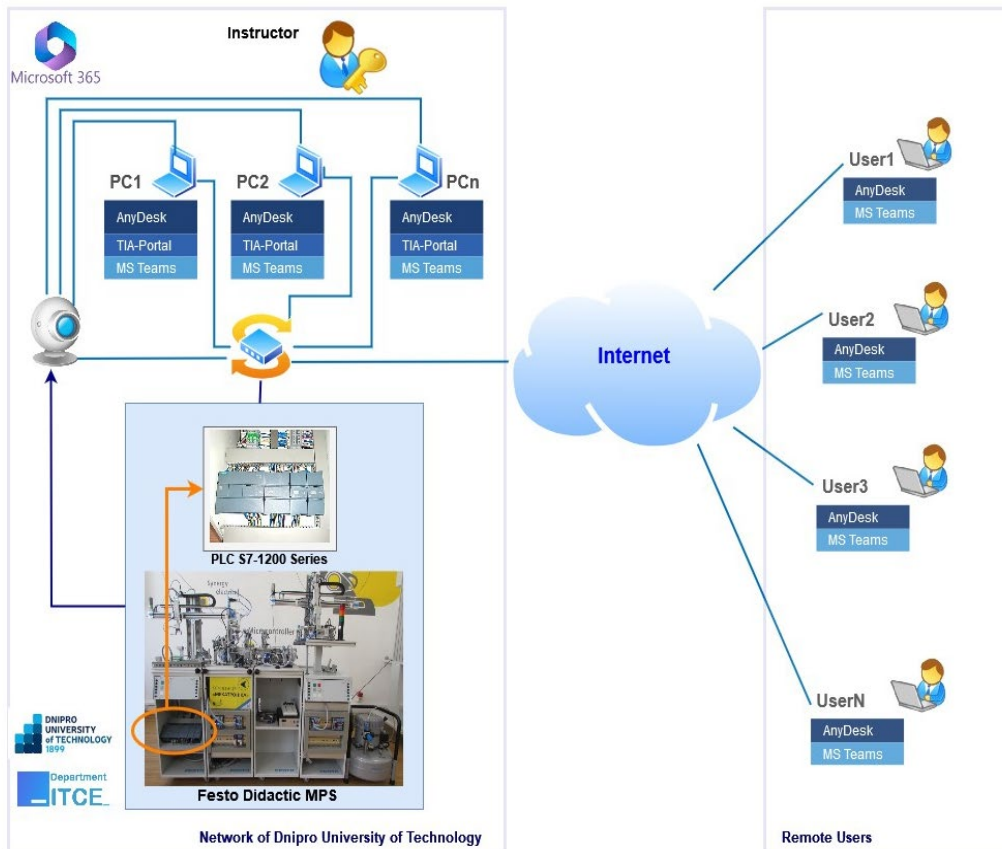


Figure 3: Digital learning space Open Agro University.

Associate professors of the ITCE Department teach the Basics of programming SIMATIC S7 TIA-Portal microprocessor control systems and Human-machine interface and TIA-Portal WINCC real-time system programming blocks. Training takes place remotely through the educational network of the Dnipro University of Technology with access to the company's laboratories using the modern TIA-Portal educational environment from the Siemens company (Fig.3), which provides unlimited access to the full range of digital services in the field of automation, from digital design to integrated design [25].

Also, the task of the higher school is to train public administration specialists capable of implementing national and regional digitization programs. In 2022, the Dnipropetrovsk Regional Council adopted the Regional program of informatization "Dnipropetrovsk region: digital transformation" for the years 2023-2025, in which among the priority areas of digital development the following were identified:

- Provision of unimpeded access to high-speed Internet in populated areas of the region (primarily rural) and social infrastructure institutions.
- Ensuring the development of 3G/4G/5G networks.
- Implementation of measures aimed at ensuring cyber security in the information space of the region.
- Increasing the level of digital literacy of the population.

The program envisages, in particular, the implementation of the following measures:

- involvement of all segments of the population in the use of digital technologies and the development of relevant digital competencies and skills, digital literacy;
- organization of training of specialists of executive authorities and local self-government bodies, including based on specialized institutions and enterprises, on issues of digital skills and competencies.

A new educational program was created for government employees in support of the digital transformation of Ukrainian society in 2022. The Masters program "Digital Governance – 281 Public Management and Administration" undergone successful accreditation at DUT in 2023. ITCE Department teaches the professional course "Digital Technologies in the public sphere." The course aims to develop skills and competencies in using digital search technologies, processing, interpretation, storage, ordering, classification, systematization, and use of information in professional activities. The taught skills include mastering the functionality of various digital technologies, knowledge of structure, and types of problems related to the use of information. The following proficiencies are expected after the course:

- modern digital systems and Internet technologies;
- modern digital technologies and software tools to optimize state management processes in the public sphere;
- determination of main requirements for the creation and functioning of the websites of public sector institutions;
- analyzing data using modern database management systems as well as designing and administering such databases.

The main tasks of studying the discipline are as follows:

- to acquaint students with conceptual components and categorical apparatus of digital technologies;
- to form development and implementation skills to ensure effective and efficient digital functioning of government entities;

- to form the ability to use modern digital technologies in public organizations, to orient applicants in the implementation of collaborative telecommunications projects, teleconferences, webinars, and chatbots in the digital society;
- teach university students to use modern methods, models, digital technologies, and specialized software to solve complex problems in public administration and to present activity results to specialists and the general public;
- to learn specialized analytical tools and interpret the results.

As part of the educational discipline, students master theoretical and practical aspects of Artificial Intelligence technologies, the Internet of Things, modern communication technologies, databases, and Virtual and Augmented Reality technologies, which are the latest technological trends and likely be very transformational for many spheres of life, such as medicine, science, education and business internationally and in Ukraine [26-29].

5. Results/discussions

Organizational approaches to the digitalization of IT education at the Department of Information Technology and Computer Engineering of Dnipro University of Technology were explored and implemented between 2021 and 2024. Novel approaches demonstrated the advantages of the functional symbiosis of programs included in Office 365. Software development skills benefited from a comfortable learning environment for first-year IT students studying foundational programming disciplines. The teaching department sees its mission as training and empowering government employees with digital skills and competencies to successfully implement national and regional programs for the digitalization of Ukrainian society via the formation of conceptual understanding and practical experience with various digital technologies. These skills will ensure effective and efficient governance in the digital society. The department plans to increase the number of instructors at the Cisco Academy and expand the courses implemented in the department's educational process. Additional training environments may soon be available to students. From September 2024, the "Siemens Authorized Training Center" of the Dnipro University of Technology will offer the formation of modern technologies for automation, control, and construction of industrial networks. The center will be equipped with advanced equipment, including programmable logic controllers (PLCs), signal input and output modules, frequency converters, conveyors, thermo-tunnel, manipulators, weighing complex, and TIA Portal software for implementing new approaches to the digitalization of the educational space to prepare competitive graduates.

6. Conclusions

The digital transformation of education today is introducing digital technologies into all aspects of the educational process, from teaching and organizing the work of teachers to evaluating and tracking student performance. This transformation has become extremely important as digital technologies have changed how people communicate, work and live. Therefore, education must know how to adapt to these changes, as well as how to use these technologies to improve the quality of education and ensure access to education.

One of the main tasks of digital transformation is ensuring education availability. Information technology can help reduce barriers to education, particularly distance from an educational institution, financial constraints, and other circumstances that can prevent access to quality education. To do this, e-courses, online resources, video lessons and other digital materials are created, which can be used for learning anytime and anywhere with Internet access.

Digital transformation in the field of education and science is comprehensive work on building an ecosystem of digital solutions in the field of education and science, including the creation of a safe electronic educational environment, provision of the necessary digital infrastructure of

institutions and institutions of education and science, increasing the level of digital competence, digital transformation of processes and services, as well as automation of data collection and analysis.

The educational space is part of a holistic “educational ecosystem”, in which pedagogical activity is an interaction between participants in the educational process, the content of education and material resources. The educational space is, on the one hand, one of the educational resources (along with educational materials and technologies, including digital ones). On the other hand, only inclusion in the educational ecosystem makes these resources truly educational spaces and not just a set of material benefits.

Declaration on Generative AI

The authors have not employed any Generative AI tools.

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