

international collective monograph

**INNOVATIONS IN THE EDUCATION OF THE FUTURE:
INTEGRATION OF HUMANITIES, TECHNICAL
AND NATURAL SCIENCES**



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The collective monograph is the result of the generalization of the conceptual work of scientists who consider current topics from such fields of knowledge as: ecology, mathematics, law, psychology, forensics, national security, state security, pedagogy, digital economy, philology, philosophy, road safety, education

For scientists, teachers, post-graduate students, masters of educational institutions, faculties of higher educational institutions, stakeholders, managers and employees of management bodies at various hierarchical levels and for everyone who is interested in current innovations in the education of the future and problems in the fields ecology, mathematics, law, psychology, forensics, national security, state security, pedagogy, digital economy, philology, philosophy, road safety, education.

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DIGITAL TOOLS AS A MEANS OF ORGANIZING AND CONTROLLING THE INDEPENDENT WORK OF FUTURE MATHEMATICS TEACHERS

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Abstract. The chapter of the monograph is devoted to the peculiarities of organizing the independent work of future mathematics teachers in the study of the discipline «Informatics». Attention is focused on the theoretical and methodological aspects of organizing the independent work of higher education students in the context of the European Credit Transfer System. The classification of certain types of independent work, as well as the forms of organization of this type of activity of students are presented. The features of independent work of future mathematics teachers in the context of the discipline «Informatics» are considered, indicating the content of the course and the number of hours allocated for individual and independent study. Particular attention is paid to the organizational and methodological support of independent work of applicants. Examples of information and methodological support used in the educational process of Pavlo Tychyna Uman State Pedagogical University, in particular in the training of future mathematics teachers, are given, and a selection of digital tools for controlling the knowledge gained during independent work is made.

Keywords: independent work, informatics, future mathematics teachers, information and communication technologies, information and digital competence, digital tools, higher education.

Introduction. The formation of a new educational system in Ukraine requires future specialists to have a deep understanding of pedagogical processes, the ability to independently formulate pedagogical problems, to creatively search for original solutions in non-standard situations, and to participate in any field of educational activity.

The changes taking place in society have a significant impact on the reform of the education sector, and they are especially noticeable in teacher education. In modern conditions, the requirements for training a future specialist have increased significantly, and teaching is no exception. In the process of professional training, a teacher should be formed who is capable of self-study, constant research and problem-solving, a teacher who will carry out educational activities at a high professional level and find new forms, means and methods of work to interest students and increase their motivation.

In view of this, there is a need to create such democratic teaching conditions that would mean active interaction of all participants in the educational process, increasing the personal responsibility of the applicant for the results of their own educational activities. It is about developing in future mathematics teachers such personality qualities that would indicate their readiness for independent practical activity.

The concept of «independent work» is interpreted by scientists in different ways: some consider it as an educational activity without the direct participation of the teacher, others – as a method or means of learning. At the present stage of development of higher education, it is desirable to look at it more broadly: independent work of students is a form of implementation of

the educational process in a higher education institution (HEI).

One of the characteristic features of the European Credit Transfer and Accumulation System (ECTS) in higher education institutions is the large amount of independent work of students. The number of hours for independent study reaches 50% or more of the hours allocated for the study of the discipline. This makes it possible to form a specialist ready for lifelong learning.

The problem of organizing the independent work of students of pedagogical HEIs is one of the most important and requires finding ways to modernize the educational process, develop new and improve existing educational technologies and ways of interaction between participants in the educational process, especially now that distance and blended learning have taken root in the educational system due to a number of negative factors, including the Covid-19 pandemic and russia's full-scale military invasion of Ukraine.

Independent work becomes predominant, while the activities of the participants in the educational process change: the applicant becomes more active, transforming from an object of activity into a subject - this contributes to an increase in the level of efficiency of independent work, which allows the applicant to engage in self-education in their future personal and professional life.

According to the Law of Ukraine «On Higher Education»¹, independent work of students is one of the main forms of the educational process of higher education institutions along with classes, practical training and control measures. The independent work of students is aimed at forming and developing their competencies as future professionals, developing skills and abilities to reflect on the content of the field of knowledge being studied and its professional tasks. Given the total digitalization of all spheres of life, the realization of these tasks largely depends on the informatics training of students. Today, a future specialist who wants to improve his or her own logical and abstract thinking, to use computer technology creatively and competently, must undergo thorough training in computer science and possess information and digital competence.

The issue of training future mathematics teachers has been covered in the works of the following domestic researchers: V. Bevz, H. Bevza, D. Voznosymenko, T. Godovaniuk, O. Matiash, T. Mahomety, M. Medvedieva, Z. Slepkan, H. Tkachuk, I. Tyagai.

A significant role in the training of pedagogical staff of general secondary, vocational and higher education institutions belongs to pedagogical HEIs, as they are called upon to train specialists in accordance with the requirements of modernity and the norms of society. The main purpose of such HEIs is to train a highly qualified teacher capable of ensuring the comprehensive development of the applicant's personality, the formation of high moral qualities, mental, physical and aesthetic abilities.

Teacher education should be carried out in accordance with the principles of fundamentalism, humanization and democratization of the educational process, as well as humanization of the content of educational material. The basis of future teachers' professional training should be fundamental scientific knowledge, courses in natural sciences, mathematics and computer science, coordinated with humanitarian knowledge to provide conditions for flexible critical thinking, self-development and lifelong learning. This process should take place with the use of ICT tools to ensure the training of a modern and mobile specialist.

To date, enough practical experience and factual material have been accumulated in methodological systems for teaching fundamental computer science disciplines, primarily computer science as an educational component. However, these systems do not sufficiently meet the new educational paradigm and the requirements that society places on the training of a modern teacher.

Thus, the methodology of organizing the independent work of future mathematics teachers in the course of studying the discipline «Informatics» needs to be significantly improved. One of the important aspects of this issue is the selection of digital tools as a means of organizing and controlling the independent work of future teachers.

Theoretical aspects of organizing independent work of higher education students

Adherence to the principles of lifelong learning has become one of the priorities of the

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modern education sector, and this also applies to higher education institutions operating under the European Credit Transfer and Accumulation System. The rapid increase in the amount of information and the emergence of new knowledge is a prerequisite for increasing the role of independent work in the acquisition of knowledge, skills and abilities by the student. It is the ability to work independently that ensures the future adaptation of specialists to further changes in the professional field. Thus, independent work of students is an important part of the educational process.

In contrast to the traditional approach to education, where the student was the object of pedagogical activity, in the modern educational space, along with the teacher, the student is a full-fledged subject capable of independently regulating the pace and content of his or her own learning activities, i.e., following an individual learning trajectory. In this new subject-subject relationship, the teacher does not just teach, but rather acts as a mentor and facilitator. The subject-subject relationship is based on active cooperation between the participants of the educational process, as a result of which the student acquires professional and general competencies, and the teacher improves his or her own pedagogical skills.

As Z. Slepkan² noted, «the new educational paradigm in relation to higher education involves the formation of competence, erudition, creativity and culture of the individual. This is the main difference from the old paradigm, which was basically a learning paradigm, the leading flag of which was knowledge, skills, abilities and education».

The idea of introducing such a paradigm is not a completely new idea. In the 70s and 80s of the last century, Professor A. Aleksyuk³ proposed a module-rating concept of education. However, it was not implemented in Ukrainian higher education institutions at that time due to the dominance of the lecture as the main form of education and the understanding of the role of the teacher as a transmitter of knowledge.

The priority area of higher education is to focus on the personal interests of the applicant, which corresponds to modern development trends. The responsibility for learning is largely assigned to students. The higher education institution carries out educational activities, mobilizes students, and does not just provide teaching, as before. According to the new paradigm, teachers create an active learning environment for students, but they do not necessarily participate in some forms of learning activities themselves. The main thing is to form students' interest and creative attitude to learning, to create conditions that will promote students' interest in learning activities.

Thus, there is a transition from the «education for life» model to the «lifelong learning» model. That is why, in the context of the modern educational paradigm and the introduction of ECTS, the independent work of students in the learning process, during which students systematically work throughout the semester, attending and actively studying in classes, is gaining new importance.

The change in the educational paradigm has led to the emergence of new teaching technologies, one of which is adaptive learning. The introduction of adaptive learning in the process of studying computer science in mathematical specialities is due to the real difference in computer science training and levels of information and digital competence of applicants. In addition, informatics in these specialities is studied during the first year, when applicants are not yet adapted to studying at a university.

The analysis of the scientific works of teachers and methodologists^{4,5,6,7} allowed us to

² Слєпкань З.І. Наукові засади педагогічного процесу у вищій школі : навч. посіб. Київ : Вища школа, 2005. 239 с.

³ Алексюк А.М. Педагогіка вищої освіти України. Історія. Теорія: підручник. Київ : Либідь, 1998. 560 с.

⁴ Медведєва М. О. Особистісно орієнтоване навчання дискретної математики у вищих навчальних закладах з використанням інформаційних технологій : автореф. дис. ... канд. : 13.00.02. Київ, 2013. 24 с.

⁵ Садкіна В.І. 101 цікава педагогічна ідея. Як зробити урок. Харків : Основа, 2008. 88 с.

⁶ Томашевський В.М., Новіков Ю.Л., Каменська П.А. Моделі процесів адаптивного навчання. *Наукові праці. Комп'ютерні технології*. 2010. № 121. Т. 134. С. 36-49. URL: <https://lib.chmnu.edu.ua/pdf/naukpraci/computer/2010/134-121-4.pdf>.

conclude that the independent work of students of mathematical specialties, including computer science, in the conditions of adaptive learning is characterized by the following features:

1) The teacher acts as a competent mentor of students in their active independent work, he organizes the educational process, determines the forms and methods of work that would contribute to improving the effectiveness of learning activities. Adaptive learning allows the teacher to choose how to present the material, and the student to choose how to learn it, to monitor their own learning activities, analyze their results and change forms and content of independent work based on them.

2) The individual personality traits of students should be taken into account in their independent work, which should be aimed at developing key and professional competences, including information and digital competences, which are extremely important in a digital society.

3) The final control and assessment of students' learning achievements should be based on the knowledge gained during lectures and practical classes, current control measures and, necessarily, on the results of independent work. The main features of adaptive control are the selection of the most optimal and effective tasks that will contribute to an objective assessment of the level of knowledge and skills of students. At the same time, a significant part of the result is made up of the current academic achievements of students and only a small part is the final control.

4) The applicant independently determines the individual educational trajectory, i.e. the pace and content of the work.

The independent work of students in the ECTS system has certain differences from the organization of independent work in the lecture and practical system. One of the features of the organization of the ECTS-based educational process in higher education institutions is the increase in the amount of time allocated for independent work by students. Therefore, the issue of optimizing the independent work of students, selecting topics and tasks that would contribute to the development of professional competencies of the future teacher is quite relevant.

One of the ECTS principles is the principle of modularity, which defines the approach to the organization of training «with the help of such methods, techniques and training activities that include active independent activity of the applicant». «The principle of priority of content and organizational independence and feedback provides for the creation of conditions for organizing training, which is measured and evaluated by the results of independent work» of applicants⁸.

In the ECTS, independent work allows:

- the teacher: to implement an individual approach to teaching the applicant; to develop productive thinking of applicants, to form their independence; to activate the cognitive activity of applicants.

- students: to control their own learning, to exercise self-control and self-assessment; to accumulate points during semester (annual) work; to have certain freedom of choice; to feel responsible for their choice; to form a subjective position in educational activities.

It should be noted that the effectiveness of the ECTS, and, consequently, the organization of independent work of students in it, requires high methodological training and pedagogical qualifications of teachers.

Scientists interpret independent work based on the concept of activity, and this approach is justified, since independent learning activity is a purposeful process as a result of which the applicant acquires new or improves existing knowledge, skills, abilities, improves and develops his or her own abilities, forms and develops competencies. But in the ECTS, the concept of independent work acquires a broader meaning. Independent work of the applicant involves the formulation of goals, planning of such work individually or together with the teacher. The independent work of the applicant becomes systematic and permeates all forms of the educational process in the university.

The following regulatory documents regulate the independent work of applicants today:

1. The Law of Ukraine «On Higher Education» of July 01, 2014 (Article 50)¹: «The

⁷ Тягай І.М. Інтерактивне навчання майбутніх учителів математики під час позаурочної роботи. *Вісник Черкаського університету. Серія «Педагогічні науки»*. 2015. № 20 (353). С. 67 – 71.

⁸ Фіцула М.М. Педагогіка вищої школи: навч. посібник. Київ : «Академвидав», 2006. 352с.

educational process in higher education institutions is carried out in the following forms: classes, independent work, practical training, control measures».

2. Regulations of the educational institution on the organization of the educational process and on the independent work of students. In particular, Pavlo Tychyna Uman State Pedagogical University has regulations «On the Organization of the Educational Process»⁹ and «On the Independent Work of Higher Education Students»¹⁰.

3. The educational program and curriculum of the specialty, which specifies a certain number of hours for each discipline, which is allocated for independent work of applicants.

The analysis of scientific literature allowed us to identify the following approaches to the interpretation of the definition of « independent work»:

- *educational activity* (M. Tomchuk, D. Chernilevsky¹¹), *various types of activities* (M. Fitsula⁸);

- *form of work of the applicant, in which the teacher is not directly involved* (I. Tyahai⁷);

- *method of teaching* (E. Honcharova¹²);

- *a means of organizing training* (O. Zelenska¹³);

- *form of training* (O. Moroz, O. Padalka, V. Yurchenko¹⁴).

According to the Law «On Higher Education»¹, independent work of students is one of the forms of organizing education along with classroom classes, practical training and control measures. The analysis of scientific sources and our research allowed us to formulate the main components of the process of organizing independent work of students:

- diagnostic (identifying individual characteristics of the student and determining his/her educational needs);

- motivational (students' understanding of the purpose of a particular activity and directing them to independent work);

- instructional and guiding (informing students about the peculiarities of working with the material for independent study, setting tasks, outlining the scope of independent work, etc);

- procedural (the process of direct implementation of independent work by applicants);

- correctional and consulting (assistance to students in correcting mistakes and consulting on difficulties that arise in the process of independent work);

- control and evaluation (control over the organization of independent work by students and evaluation of their activities).

The analysis of the psychological, pedagogical and methodological literature allowed us to identify the following types of independent work of students according to various characteristics.

By compulsory:

⁹ Положення «Про організацію освітнього процесу в Уманському державному педагогічному університеті імені Павла Тичини». УДПУ імені Павла Тичини | Уманський державний педагогічний університет імені Павла Тичини.

URL: <https://udpu.edu.ua/documents/doc/Документи%20з%20організації%20освітнього%20процесу/Навчально-методична%20документація/Положення%20про%20організацію%20освітнього%20процесу%202022.pdf?ver=1677593472>.

¹⁰ Положення «Про самостійну роботу здобувачів вищої освіти в Уманському державному педагогічному університеті імені Павла Тичини». УДПУ імені Павла Тичини | Уманський державний педагогічний університет імені Павла Тичини.

URL: <https://udpu.edu.ua/documents/doc/Документи%20з%20організації%20освітнього%20процесу/Навчально-методична%20документація/Положення%20про%20самостійну%20роботу%20ЗВО.pdf?ver=1609753549>.

¹¹ Чернілевський Д.В., Томчук М.І. Педагогіка та психологія вищої школи: навч. посібник. Вінниця: Вінницький соціально-економічний інститут Університету «Україна», 2006. 402с.

¹² Гончарова Є.Є. Самостійна робота здобувачів вищої освіти в умовах дистанційної форми навчання. *Сучасні тренди розвитку медичної освіти: перспективи і здобутки* : матеріали навч.-наук. конф. з міжнар. участю, м. Полтава, 24 березня 2022 р. Полтава, 2022. С. 66–67.

¹³ Зеленьська О. Самостійна робота здобувачів вищої освіти як важлива складова організації навчального процесу у закладах вищої освіти. *Перспективи та інновації науки*. 2022. № 13(18). URL: [https://doi.org/10.52058/2786-4952-2022-13\(18\)-173-186](https://doi.org/10.52058/2786-4952-2022-13(18)-173-186).

¹⁴ Мороз О.Г., Падалка О.С., Юрченко В.І. Педагогіка і психологія вищої школи : навч. посібник. Київ : НПУ ім. М. Драгоманова, 2003. 267 с.

- 1) Obligatory – independent work, which is provided for by curricula and work programs.
- 2) Desirable – independent research, information gathering; scientific work of applicants (preparation of reports, conference abstracts).
- 3) Voluntary – work in extracurricular time, participation in competitions of various levels, contests, quizzes.

By the nature of educational and cognitive activity:

- 1) Independent works of a reproductive nature or according to a model contribute to the assimilation of educational material, but do not develop creativity.
- 2) Constructive-variative works ensure the need to reflect not only the functional characteristics of knowledge, but also its structure and the involvement of previously acquired knowledge in solving various tasks and problem situations.
- 3) Heuristic independent work is aimed at solving individual issues raised in lectures or practical classes. During the performance of such works, the ability to identify the problem of study, formulate it independently and develop a plan for its solution is formed.
- 4) Creative research work means that applicants should try to move away from the model and use their own methods of solving problem situations, thus making the work research. In the course of such independent work, the realization of the creative abilities of the student takes place¹⁵.

By the level of motivation of students:

- 1) Low level, when the teacher both encourages the student to act and controls the process of performing independent work.
- 2) Medium level, when the teacher encourages the student to work, but the student controls himself, working independently.
- 3) High level, in which the student independently selects and processes tasks.

Homework is a separate type of independent work, as it is performed without the direct intervention and control of the teacher. Homework should be differentiated and individualized, so that the learning process as a whole becomes more effective. Such differentiation will help to eliminate the overloading of students with homework, which means reducing the volume of tasks and increasing the amount of time for their preparation.

One of the components of the professional training of applicants studying in the specialty 014.04 Secondary Education (Mathematics) and the educational and professional program Secondary Education (Mathematics. Informatics) at Pavlo Tychyna Uman State Pedagogical University is the discipline «Informatics». The course is professionally oriented and is designed to be taught during two semesters of the first year of study.

The specificity of computer science education in pedagogical higher education institutions requires systematic independent work of students, which is provided for in the curriculum. The discipline «Informatics» in pedagogical higher education institutions is rich in content, but quite often very few hours are allocated for its study.

Thus, at Pavlo Tychyna Uman State Pedagogical University, the curriculum for bachelors in the specialty 014.04 Secondary Education (Mathematics) includes the following distribution of hours for studying computer science (Table 1.1).

Table 1.1

Total amount of hours	Lectures	Laboratory classes	Independent work	
			Hours	% of the total volume
240	46	74	120	50

Therefore, it can be argued that out of this number of hours, half of the total hours are

¹⁵ Воевідко Л. Організація самостійної роботи здобувачів вищої освіти. *Педагогічна освіта: теорія і практика*. 2018. Т. 2, № 25. С. 21–28. URL: <https://doi.org/10.32626/2309-9763.2018-25-2.21-28>.

allocated for independent work of students. There is a problem of organizing the independent work of future mathematics teachers in the study of computer science, in particular, its effectiveness and efficiency of learning the educational material.

Methodological features of the organization of independent work of applicants in the course of studying the course «Informatics»

Informatics is a discipline that forms the basis for the training of any modern specialist, and pedagogical specialties are no exception. It is difficult to overestimate the impact of information and communication technologies on society. The use of ICT in the educational process can significantly increase the level of motivation of students to learn, diversify learning activities, interest and involve different organs of perception of information, which facilitates the process of memorization and improves learning. All this makes us think about the importance of developing teachers' information and digital competence.

In addition, it is important to remember that we are talking about the training of future math teachers. It is important to note that confident mastery of ICT skills, especially in the context of distance and blended learning, is critical, because a single blackboard (physical or online) is not always enough to organize a quality learning process. Gamification tools (Kahoot, LearningApps, WorldWall)¹⁶, services for building spatial images and function graphs (Desmos, GeoGebra)¹⁷ and other online resources aimed at helping teachers address educational needs (JustClass, Mozaik^{18,19}, etc.) are becoming indispensable in the work of a math teacher. For example, Mozaik Education is a digital platform that contains educational materials in the form of digital lessons, 3D scenes, videos, and graphic images that allow students to learn about certain aspects of computer science in an interesting way^{18,19}.

The purpose of the computer science course is to form the basis of the student's information culture, which provides the opportunity to use the acquired knowledge, skills and abilities both in studying the theoretical foundations of computer science and in solving daily practical tasks, including professional ones. This goal is achieved by studying the relevant sections of the course and consolidating the knowledge gained. At the same time, the course aims to provide:

- deep understanding of the relevant sections of computer science;
- mastering the methods of solving problems using information and communication technologies;
- mastering the methods of working with information, including searching, processing, and storage;
- application of modern computer and multimedia tools for educational activities.

As a result of studying the discipline, the course «Informatics» should form the following knowledge and skills:

- master the basic concepts and facts in the field of computer science;
- master the basic methods of searching and selecting information, critically evaluate it and use it to solve personal and professional problems;
- master the skills of working with information and communication technologies to support the educational process.

The educational material of the discipline is divided into content modules and topics by the

¹⁶ Тітова Л. О. Визначення засобів гейміфікації для впровадження в освітній процес. Освіта України в умовах воєнного стану: управління, цифровізація, євроінтеграційні аспекти: матеріали IV міжнар. науково-практ. онлайн-конф., м. Київ, 25 жовтня 2022 р. Київ, 2022. С. 201-202.

¹⁷ Тітова Л.О. Аналіз сучасних онлайн-засобів для формування інформаційно-цифрової компетентності майбутніх учителів математики. Актуальні проблеми підготовки сучасного педагога: теорія, історія, практика : XIII Всеукр. наук.-практ. онлайн-конф., м. Умань, 24 листопада 2022 р. Умань, 2022. С.128-132.

¹⁸ Ковтанюк М., Криворучко І., Тітова Л. Можливості використання сервісу mozaWeb у підготовці майбутніх учителів математики. Наукові інновації та передові технології. 2022. № 9(11). С. 98–107. URL: [https://doi.org/10.52058/2786-5274-2022-9\(11\)-98-107](https://doi.org/10.52058/2786-5274-2022-9(11)-98-107).

¹⁹ Ткачук Г.В., Медведєва М.О. ІКТ як засіб формування інформаційно-цифрової компетентності студентів педагогічних університетів. *Молодь і ринок*. 2023. № 1/209. С. 74–80. URL: <https://doi.org/10.24919/2308-4634.2023.272479>.

teacher, which is reflected in the working curriculum of the discipline and approved at a meeting of the department. The working curriculum in computer science defines:

- the thematic plan, which indicates the number of modules
- the number of hours to study each module;
- distribution of hours of classroom and independent work of students;
- content of the discipline by modules;
- topics of lectures and laboratory classes;
- topics for independent study;
- topics of individual research tasks;
- methods of teaching and control;
- evaluation criteria for each of the activities provided for in the work program, including the final control in the form of an exam;
- list of main and additional sources, information resources.

At Pavlo Tychyna Uman State Pedagogical University, the discipline «Informatics» is studied for one academic year in the first year. The course is 240 hours in total, including 120 classroom hours and 120 hours of self-study, with the final exam as the form of control.

The structure of the discipline involves the study of the following modules:

Content module 1. PC hardware and software. Operating system.

Topic 1. Information technologies and processes. Computer as an information system. Theoretical foundations of information presentation.

Topic 2. Working with operating system objects. Data archiving. Archiving programs.

Content module 2. Information processing by means of office programs.

Topic 1. Working with documents in a word processor. Formatting text, paragraphs and pages.

Topic 2. Using styles in a word processor. Creating standard and custom templates, calendars, letters, resumes using a word processor.

Topic 3. Working with table structure in a word processor. Creating lists. Mathematical formulas. Data visualization.

Topic 4. Creating a presentation of a branched structure. Adding animation, music and video.

Topic 5. Publishing systems. Creating a business card and newsletter.

Topic 6. Databases. Database management systems.

Content module 3. Fundamentals of computer graphics. Graphic editors.

Topic 1. Computer graphics. Graphic editors. Creating graphic images.

Topic 2. Modern raster and vector graphics editors.

Content module 4. Google digital tools in educational activities. Professional software tools.

Topic 1. Cloud technologies and opportunities to use Google's digital tools in the educational process.

Topic 2. Cloud and software tools in the professional activity of a mathematics teacher.

Theme 3. Web resources in the professional activity of a mathematics teacher.

Content module 5. Educational web services and mobile technologies.

Topic 1. Infographics. Web resources for working with infographics. Photo stocks.

Topic 2. Cloud and mobile services for creating presentations.

Topic 3. Resources for creating interactive tasks.

Topic 4. Online services for creating tests.

Topic 5. Mobile applications for testing.

Topic 6. Interactive posters and mind maps.

Topic 7. Time tapes and word clouds. Web resources for generating QR codes.

The specificity of the computer science course for future teachers, including mathematics, is to familiarize, develop and improve practical skills in working with software and hardware computer tools that will allow them to carry out professional activities and solve personal problems efficiently and effectively in the future. That is, the course is aimed at forming the future teacher's information and digital competence, which is key to life and is one of the professional competencies of a modern teacher.

Accordingly, the analysis of scientific research on the problems of training a modern mathematics teacher shows that the current situation is characterized, firstly, by the development of the mathematical field of knowledge, education reform and the development of state standards of higher education, and secondly, by a decrease in the number of hours allocated for classroom classes and the introduction of a significant part of the material for independent study. Particular attention should be paid to the organization of systematic control over students' independent work.

Clearly identifying in each section of the program material that is submitted for independent study (and this component of the training content can be varied depending on the individual capabilities of each applicant or academic group) will help to think through the content and forms of control of applicants' knowledge during the semester, which should be introduced to applicants at the beginning of the semester.

In the process of studying computer science, future mathematics teachers should gradually form the conviction of the need to acquire in-depth knowledge, as this is important for ensuring the effectiveness of further education and professional activity.

The needs for the formation of knowledge, skills, abilities and qualities provided by the competency-based approach and which must be mastered by a computer science student to solve professional problems are called educational needs. When determining educational needs, the teacher, together with the applicants, should consider the model of professional competencies defined by the Professional Teacher Standard²⁰, which should be achieved as a result of training by each applicant.

The traditional combination of «knowledge-skills-abilities» to describe the result of learning activities is a necessary condition, but not sufficient. For the future mathematics teacher, the concepts of «professionalism» and «competence» are important.

Professionalism is understood as the degree of mastery of certain technologies, and competence includes, in addition to technological training, a number of other components (these include components of an external professional nature, but are necessary for every specialist in one way or another, including independence, the ability to make decisions in problem situations, creativity, the desire and ability to self-learn, flexibility of thinking, etc.)²¹.

A future math teacher acquires such qualities to a greater extent during independent work. A teaching methodology that focuses on building the educational process according to the educational outcome (using the competencies of the future specialist) is called a competency-based approach.

The concept of "competence" includes the following components: readiness for goal setting, for action, for evaluation and reflection, primarily of one's own actions²². The change in the educational paradigm implies a competency-based approach to education.

Competence in the study of informatics in the future mathematics teacher should be manifested in the ability to:

- recognize problems that arise in the independent study of the material that can be solved by means of ICT;
- solve these problems using computer science knowledge.

An important condition for the effectiveness of the student's independent work is goal setting, since the goal is one of the defining components of the educational process. A clear definition of the goals of independent work by the teacher, as well as the awareness and acceptance of them by students, is a necessary element of the organization and implementation of independent work.

The purpose of independent work in computer science is to expand and consolidate

²⁰ Про затвердження професійного стандарту за професіями «Вчитель початкових класів закладу загальної середньої освіти», «Вчитель закладу загальної середньої освіти», «Вчитель з початкової освіти (з дипломом молодшого спеціаліста)»: Наказ від 23.12.2020 р. № 2736-20. URL: <https://zakon.rada.gov.ua/rada/show/v2736915-20#Text>

²¹ Khorzhevskaya I. Professionalism and an individual's professional development. *Science and Education*. 2016. Vol. 15, no. 11. P. 55–60. URL: <https://doi.org/10.24195/2414-4665-2016-11-11>.

²² Педагогіка вищої школи: навч. посіб. / упоряд. З.Н. Курлянд. Київ : Знання, 2007. 495 с.

knowledge and skills in the field of information and communication technologies, to acquire skills in their practical application, as well as to develop an attitude to systematic, continuous updating of knowledge.

In accordance with the goal, we have identified the tasks of independent work in the study of computer science:

- to creatively perceive and comprehend the educational material;
- to develop skills of daily independent work in obtaining and generalizing knowledge, skills and abilities in computer science.

The purpose of independent study of the material should be related to the goal of achieving the skills of independent work in computer science, such as: the ability to make a synopsis, the ability to solve problems independently, to search for information using ICT, and others. The following skills are also important: designing the purpose of studying modules by applicants, selecting tools and literature according to the topic, drawing up tasks in accordance with the goals set, etc.

Students' independent work in computer science should be implemented taking into account general didactic principles (systematic, consistent, accessible, individual approach, consciousness and independence), ECTS principles, andragogy principles, principles of personality-oriented learning and activity-based approach.

At the present stage, university teachers are faced with the task of revealing the real capabilities of the applicant, which requires not unification and uniformity of training, but the identification and development of individual inclinations and abilities of the future specialist, as well as the use of innovative teaching tools and methods, including the widespread introduction of information and communication technologies. A differentiated approach involves an understanding of individualization of learning that consists in planning the level of mandatory learning outcomes and, on this basis, higher levels of mastery of the learning material.

Individualized learning is the organization of the educational process that allows each student to learn, develop and form their own competencies according to an individual plan adapted to their abilities and needs, at their own pace.

Differentiation and individualization of learning, including independent work, are central to the work of higher education institutions in Ukraine. The relevance of the problem of differentiating independent work is due to the different levels of preparation of graduates of general secondary education institutions (different types of institutions, individual characteristics of students, their potential capabilities, adequacy of the choice of an educational institution for further study to the level of preparedness of the applicant, inability to work independently since school, etc.)

Another important issue is the intensification of independent work. There are various methods of enhancing students' independent work, which are primarily related to the development of interest in the discipline being studied.

According to the new paradigm, learning becomes a form of human activity. The ability of a student to learn independently, without the direct guidance of a teacher, is a quality that a modern personality needs in any professional activity.

Digital tools for monitoring the learning achievements of future mathematics teachers during independent work

The effectiveness of the process of training a modern teacher depends on a number of factors, one of which is the independent work of students. In the educational process of a higher education institution based on the ECTS system, a significant number of hours are allocated to the independent work of students. Therefore, one of the main tasks of a HEI teacher is not to reproduce a set of ready-made knowledge, but to organize active learning activities of students, including independent work.

Given the growing role of independent work and the increase in the number of hours allocated for independent study of educational material, the problem of organizing independent work of students, in particular of pedagogical HEIs, has become widespread. However, given the

total digitalization, the issue of using information and communication technologies in the process of organizing students' independent work is becoming more relevant.

The stage of planning students' independent work in the system of professional training of future mathematics teachers is one of the most important. In the process of planning, the teacher mentally comprehends the content of the future independent work, determines the timing of its implementation, predicts its final results, etc.

To ensure the effectiveness of independent learning activities, the teacher needs to set goals correctly, think about what methods and tools will be used in organizing and implementing students' independent work, and compare the goals and results obtained. In the course of this type of work, an active position is necessary, which requires a high level of organizational skills.

An important task of university teachers is to properly organize independent work and provide conditions for their successful completion, which requires not only fundamental and scientific, but also appropriate pedagogical training, which allows them to conveniently activate the cognitive abilities of students in the process of pedagogical influence on the educational process.

In order for independent work to bring decent results, it needs to be planned and organized in combination with other forms of education. The most important among them is the careful selection by the teachers of graduate departments of the content and amount of educational material for independent study by students, and the means of testing the knowledge acquired in the process of independent work.

One of the stages of planning independent work is the selection of forms and methods that will most favorably affect the educational environment for the applicant.

We will distinguish between two forms of independent work of applicants: classroom and extracurricular. The classroom form involves completing tasks directly during lectures and laboratory classes. The extracurricular form of independent work of applicants involves the allocation of special tasks for independent performance by applicants for each module at home, in the library, in computer classrooms.

Among the forms of organization of independent work both in and out of the classroom, it is advisable to use frontal, group, pair and individual forms of work of applicants.

The frontal form involves the independent completion of common tasks assigned by the teacher and is conducted in an academic group. An example of frontal independent work in computer science is a module test in the classroom; outside the classroom, it is a search for theoretical material on a particular topic, compiling a reference outline, completing a project, or performing interactive tasks using information and communication technologies²³. This form retains the ability to individualize learning by selecting differentiated tasks.

During the group form of independent work, the academic group is divided into microgroups of 3-4 students. Each of the microgroups performs tasks assigned by the teacher. An example of a group form of organizing independent work is the performance of small-scale creative works, similar to those performed in the classroom during laboratory classes or large complex works that would include the material of one or more content modules. For example, developing a project with its subsequent presentation. The latter can be effectively performed with computer support.

The pair form is convenient to use in the classroom, using static, dynamic and variation types of pairs. An example of a pair form of independent work is the work of applicants in pairs – their independent performance of tasks of different levels of complexity and different types, with subsequent mutual verification.

The individual form of independent work involves each applicant writing an individual educational and research task in the form of an abstract or abstracts for a conference, or creating multimedia presentations using cloud services (Canva, Prezi, Powtoon, Google Presentations,

²³ Інноваційні технології навчання інформатичних дисциплін : колективна монографія / [І.С. Безноско, Д.С. Джога, М.С. Ковтанюк, І.І. Криворучко, С.Ю. Куценко, Л.О. Тітова, Я.В. Ярошик]; за заг. ред. М. О. Медведєвої, І. М. Тягай ; МОН України, Уманський держ. пед. ун-т імені Павла Тичини. Умань : Візаві, 2021. 231 с.

VistaCreate etc.). Planning individual forms of work and performing these types of work by students teaches them to plan their own activities and acquire independent skills.

Another important condition for the implementation of independent work of students is the definition and creation of organizational and methodological support, which includes organizational, information, methodological, control and diagnostic support for the study of the computer science course and the organization of access to it for students.

We propose to call organizational support the creation and communication of organizational information necessary for independent study of the material to students. At the first lecture classes, it is advisable to inform students about:

- The main information sources: the library, the Moodle distance learning environment and the university repository, which will be used in the study of the educational component of Informatics. It is important to emphasize that students will search for the necessary information for independent study of the material on computer science on their own. At the beginning of the course, it is advisable to inform students about the university's Moodle distance learning environment, provide an email address, tell them more about the educational and methodological complex in computer science, explain the structure and purpose of the educational and methodological material posted in the Moodle distance learning environment.

- The schedule of consultations of the teacher according to the academic load. The consultation schedule should be posted on the department's website.

- Evaluation criteria (activity in the performance of work, the procedure for studying and forms of control over the study of material, deadlines for completion of work, requirements for the design of laboratory, creative and individual educational and research works, etc.).

- A list of topics and individual issues in computer science that are submitted for independent study. Such information is available in the discipline's textbook, work program, and in the university's Moodle distance learning environment.

Such information support allows us to intensify and improve the independent work of students, save time on preparing for lectures and laboratory classes, and realize an interactive dialogue between teachers and students.

The information and methodological support should provide applicants with access to the necessary information and methodological materials, indicate the direction of study of the educational material set by the teacher, and guide applicants in choosing their own educational trajectory during independent work. This support includes a working curriculum with the division of educational material into modules and the allocation of material by type and volume for independent work, as well as methodological sources for studying lecture material with examples of solving practical problems (paper and electronic lecture courses, textbooks, workshops, reference books, etc.).

Information and methodological support can also include platforms with massive open online courses, which have recently gained considerable popularity. In the practice of modern higher education institutions, including Pavlo Tychyna Uman State Pedagogical University, the procedure for recognizing the results obtained in non-formal education is widespread. Thus, the platforms that allow to acquire new knowledge, skills, and abilities are Prometheus, Coursera, Cisco Academy, Udacity, Udemy, EdEra and others. The use of courses on these platforms allows applicants to follow their own educational trajectory, in particular through a wide range of courses and opportunities to learn at their own pace, increase their level of professionalism, and develop self-education skills. This approach ensures mobility and accessibility of education, as well as adherence to the principles of person-centered learning²⁴.

An important point in organizing students' independent work is the creation of *control and diagnostic support* by the teacher. It provides feedback between the teacher and the student and helps students to realize an individual educational trajectory, which is one of the key requirements

²⁴ Медведєва М.О., Жмурко О.І., Криворучко І.І., Ковтанюк М.С. Використання масових відкритих онлайн-курсів у підготовці майбутніх учителів інформатики. Інноваційна педагогіка. 2021. Випуск 33(2). С.159-164.

of a personality-based approach to learning.

Successful learning is largely related to the organization of control and testing of students' knowledge. In connection with the transition of educational programs to the ECTS system, the amount of independent work is increasing, so in such a situation, the teacher should more carefully approach the problem of controlling students' knowledge.


The control and diagnostic support should include the implementation and presentation of the results of an individual educational and research task, tests and interactive tasks using information and communication tools, as well as final control in the form of a test or exam.

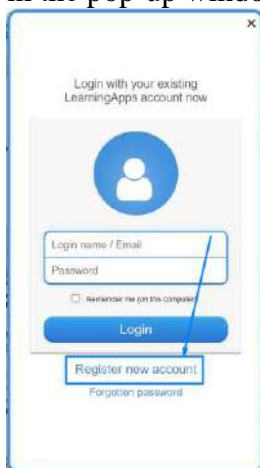
Various types of knowledge testing have been used in modern HEI practice, but nowadays more and more teachers are using information and communication technologies for testing and control. One of such tools used at Pavlo Tychyna Uman State Pedagogical University is testing in the Moodle educational and information environment. In the course of the discipline being taught, the teacher creates an appropriate test that allows for a quick and objective assessment of the student's knowledge. However, the most widely used services are those for instant testing and interactive exercises. Such tasks become part of the current and final control, and sometimes completely replace it²⁵. Students perceive such forms of control with interest, considering them to be a game to some extent. This method of control, if effective, requires little time to implement knowledge accounting. This is one of the advantages over other classical methods of knowledge control. Let's look at some services for creating interactive tasks and tests.

LearningApps.org

The LearningApps service is one of the most popular for creating interactive learning tasks. This web service is completely free and allows you to create tasks of varying complexity for different age groups, using ready-to-use templates. The service is multiplatform and supports 22 languages, including Ukrainian, which is very convenient for use. The interface of the online service is intuitive and allows both registered users and those without an account to create interactive exercises. However, in order to fully use the service and to be able to save created exercises and add them to the relevant thematic catalogs, you need to register.

In order to create your own account, you need to go through the registration process, which includes the following steps:

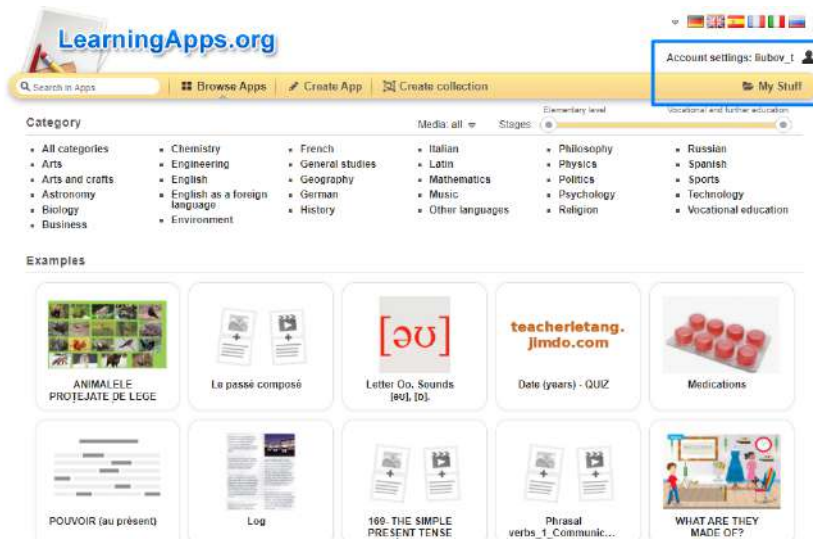
- Click on the «Register» button  in the upper right corner of the screen;
- Select «Create a new account» in the pop-up window;



- Fill in all the required fields (Login, Email, Password) and agree to the terms of use of the service.

²⁵ Криворучко І.І., Ковтанюк М.С. Використання інтерактивних технологій в освітньому процесі. Інформаційно-комп'ютерні технології – 2021 (ІКТ-2021) : тези доп. XII Міжнар. науково-техн. конф., м. Житомир, 1–3 квіт. 2021 р. Житомир, 2021. С. С. 145–146.

After completing all the above steps, the user will receive an account and can work on creating interactive tasks.



The service has a large number of templates that users can work with to create their own exercises, and you can also use or modify ready-made interactive tasks created by other teachers. Most of the templates allow you to add videos and images.



The advantages of this service include the following:

- free use;

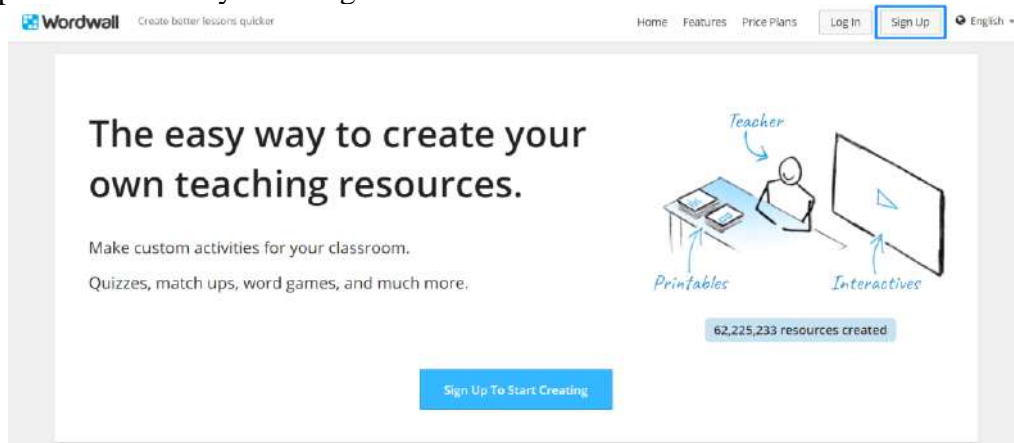
- multilingualism (including the presence of Ukrainian);
- intuitive interface;
- numerous available templates;
- the ability to exchange interactive tasks;
- URL and HTML code are available, which allows you to share the link to the exercise, embed it on your own website or blog²⁶.

Wordwall

Wordwall is designed for interactive creating interactive tasks and is similar to LearningApps, but has much more features if you purchase a paid tariff plan.

Wordwall, like LearningApps, is multilingual, and Ukrainian is available. This web service is based on «a method used in American schools to create a collection of words that is posted on the classroom wall to help students memorize and use new words or terms». That is, the main purpose of the web service is to work with words, but it is quite convenient to use it to master the terminology of completely different fields of science²⁷.

Before you can start using the web service, you need to register. To do this, on the main page of the website <https://wordwall.net/>, click on the «Register» button and fill in all the fields of the pop-up window or use your Google account.



Sign Up to a Basic account

OR

Location

I accept the [Terms of use](#) and [Privacy policy](#)

²⁶ Остополець І., Варіна Г. Особливості застосування «LearningApps» в роботі зі студентами педагогічного університету. *Професіоналізм педагога: теоретичні й методичні аспекти*. 2021. № 15. С. 142–149. URL: <https://doi.org/10.31865/2414-9292.15.2021.242970>.

²⁷ Тарасова Т. Особливості використання сервісу Wordwall в освітньому процесі закладу позашкільної освіти. *Distance Education in Ukraine: Innovative, Normative-Legal, Pedagogical Aspects*. 2023. № 3. С. 414–424. URL: <https://doi.org/10.18372/2786-5495.1.17804>.

After registration, a user with the Basic plan has 18 templates available, with which they can create 5 tasks. If you purchase a paid plan, the number of available templates and the number of exercises you can create increases.

Upgrade your account [School plans >](#)

Pay Monthly Pay Annually (Save 10%)

	Basic Free	Standard € 60 / month UAH	Pro € 90 / month UAH
Interactives	18 ▾	18 ▾	33 ▾
Printables	0 ▾	17 ▾	17 ▾
Number of resources you can create	5	Unlimited	Unlimited
		Upgrade	Upgrade

The feature of this service is the ability to customize the theme, fonts, and time to complete the task, as well as the presence of gamification elements (changing the number of lives, displaying the list of winners), which makes the process of solving an interactive exercise even more interesting and motivating.

Theme < >

Primary Autumn Whiteboard Underwater Magic Library Summer Clouds Detective Winter

FONTS

Default abc 123 ▾

Options

TIMER None Count up Count down 5 m 0 s

LIVES 5

DIFFICULTY

Display words to find

Allow diagonal words

Allow reverse words

Lower case letters

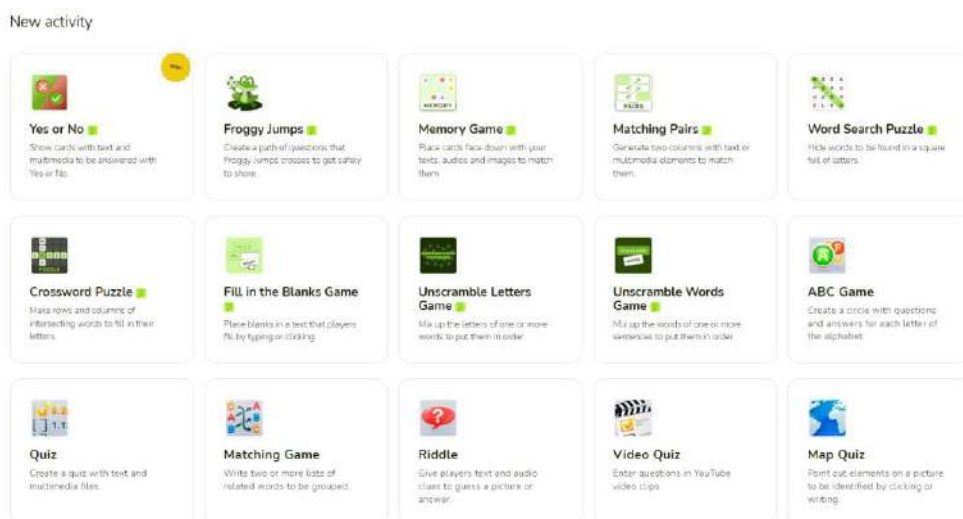
END OF GAME Show answers

[Apply To This Activity](#) [More ▾](#)

A characteristic feature of this service is that the created exercises can be saved in PDF format for further use during training sessions in both electronic and printed formats.

Educaplay

Educaplay is an online service that allows you to create interactive educational tasks. Educaplay is designed to use gamification technology in the educational process, allowing students to learn through play.



The service has a free Basic tariff plan that allows you to create many interactive tasks, but limits the ability to integrate ready-made exercises into other services. The advantages of Educaplay include the following:

- eighteen constructors for creating interactive tasks (quizzes, memorization games, crosswords, etc.) in the free version and fifteen more (a quiz with images, a math generator, and various game exercises) if you purchase the Pro tariff plan;
- you can add both text and graphic and video information to tasks;
- the ability to integrate the created tasks into compatible services (Google Classroom, Microsoft Teams, Moodle, CANVAS, etc.) and distribute them on social networks, personal websites and blogs;
- generating a report on the completion of the task by the applicants in the form of an infographic²⁸.

Interestingly, interactive tasks on the web service can be created using artificial intelligence. To do this, you just need to specify the topic of the task in the appropriate window and press Enter, after which Educaplay will generate ten questions on the selected theme.



However, a small disadvantage of this service is the lack of Ukrainian language both in the website interface and in the settings of interactive tasks.

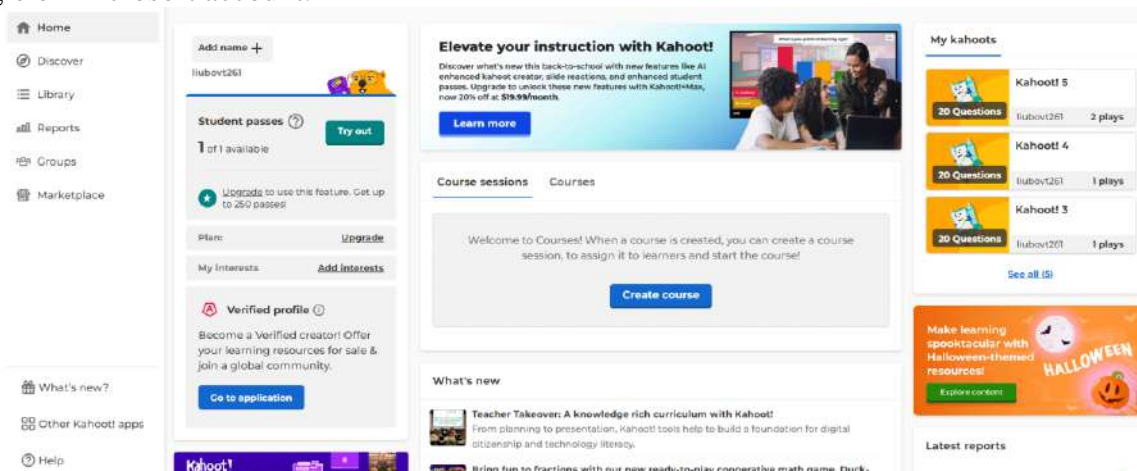
There are also numerous services for creating tests, including Kahoot!, Quizlet, Quizizz, Plickers, Google Forms, and others.

Kahoot!

Kahoot! is a platform designed to create and conduct quizzes and tests. The resource is conditionally free and can be accessed from both a personal computer and a smartphone, provided that you have an Internet connection.

²⁸ Горкуша В. Гейміфікація освітнього процесу у початковій школі з використанням ресурсу «Educaplay». *Проблеми і перспективи розвитку освіти XXI століття* : тези доп. Всеукр. студент. Інтернет-конф., м. Умань, 11–12 листоп. 2020 р. Умань, 2020.

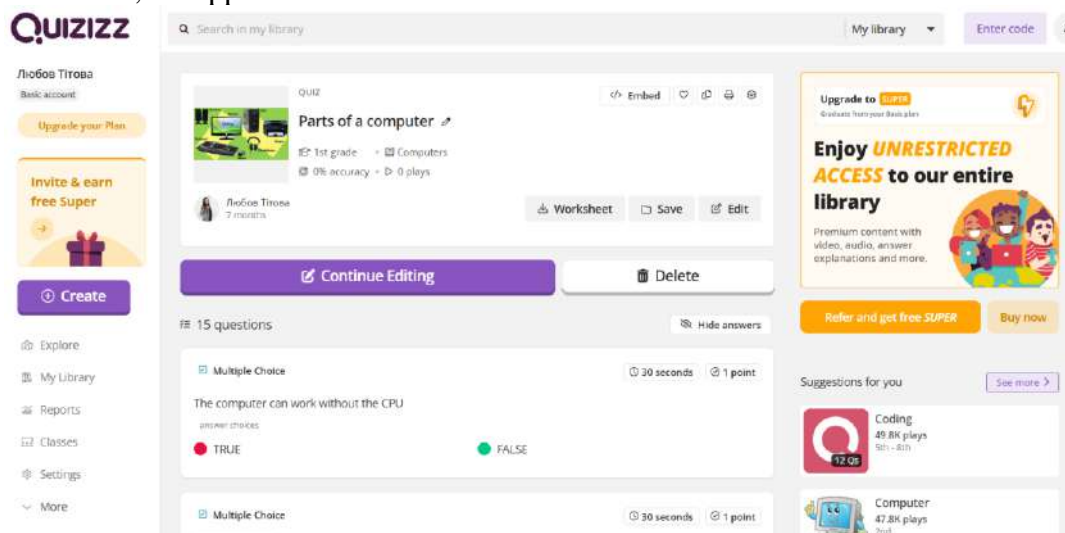
Users can create tasks only after registration, and the service allows them to work with accounts of different types (Teacher, Student, Personal and Professional) and tariff plans of different cost and functionality, including a free one with limited capabilities. After registering, users can create their own "kahoots" and combine them into courses, which is very convenient for structuring training materials if necessary. You can also register at <https://kahoot.com/> using your Google or Microsoft account.



You can add not only textual information but also graphics, animations, or videos to the quiz. The teacher can use the points for evaluation or to stimulate students, as after each question, the top three leaders who answered the question correctly and quickly are highlighted. You can use ready-made templates or create your own²⁹.

Quizizz

Quizizz is a web service for creating quizzes and tests that has a similar principle of operation to Kahoot! You need to register to use the service, but just like Kahoot! you can use Google, Microsoft, or Apple accounts.



The finished test can be used in real time in the classroom or via videotelephony by selecting the Play Live mode, or set for self-study in the Homework mode. The service allows you to monitor the progress of each student and export data to Excel. The teacher has access to a library of ready-made tests, or he or she can create a test, game, or survey on his or her own³⁰.

²⁹ Дистанційні технології в освіті: збірник науково-методичних рекомендації щодо організації виховання, навчання та розвитку учасників освітнього процесу під час карантину / ред.: Ю. Бурцева, Д. Малєв. Краматорськ, 2020. 95 с.

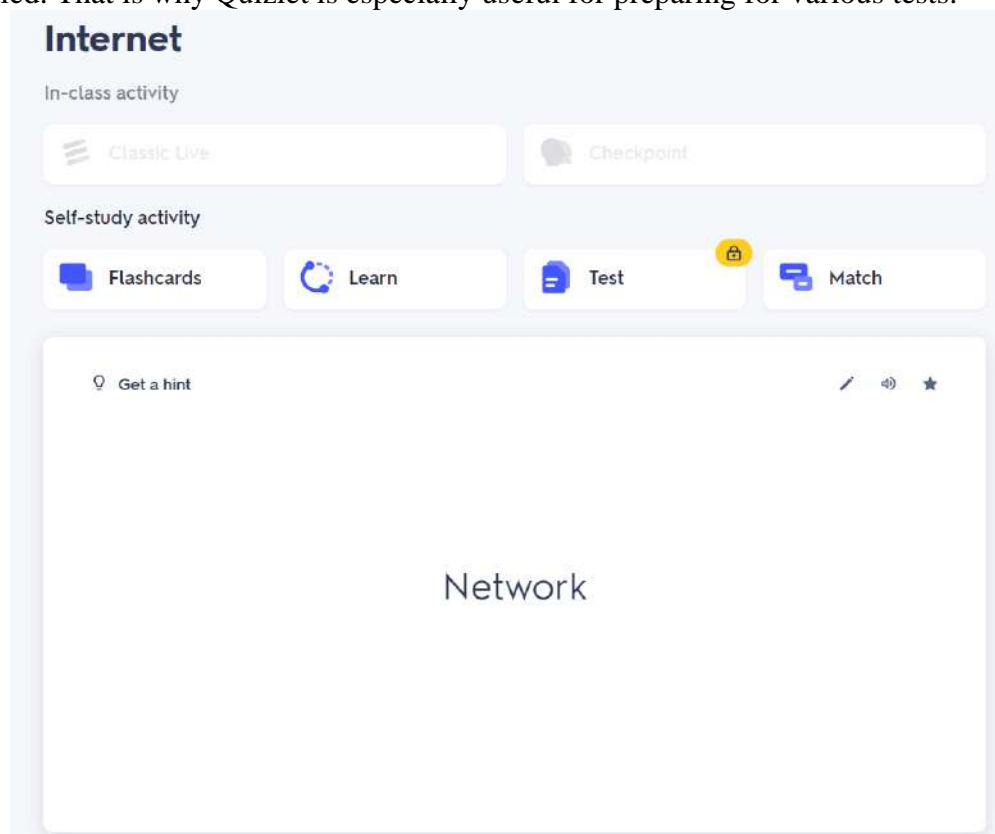
³⁰ Освіта.ua. Створення тестів для онлайн-навчання: огляд платформ. *Освіта.UA*. URL: https://osvita.ua/vnz/high_school/80118/.

Quizlet

Another interesting service that will become both a supplement to the teacher's work and a tool for studying theoretical material and self-checking in the process of independent work of the student is the service for creating flashcards and tests Quizlet. This service, like the previous ones, requires registration or logging in with a Google or Apple account.

Working in the Quizlet environment means creating flashcards with terms and their definitions, which can be used in 3 modes of the free plan – Flashcards, Learn and Match, as well as in the testing mode if you purchase the QuizletPlus plan.

Each of these modes will help the student to better master the terminology of the discipline being studied. That is why Quizlet is especially useful for preparing for various tests.



The use of such services in pedagogical activities will not only help to control the knowledge gained in self-education, but will also interest students and motivate them to learn, due to its interactivity and gamification elements. On the part of the teacher, the use of such services to check students' academic achievements ensures, firstly, objective assessment, instant feedback, and reduces the time spent on the check.

Conclusions and suggestions. The independent work of students should be interpreted as an organizational form of the educational process in a higher education institution, which is implemented in the form of various forms of activity (frontal, group, individual), based on the active interaction of the teacher and the student, is of a partnership nature and takes different forms depending on the purpose of independent work.

The methodological foundations of independent work of students that will positively affect the process and results of work include the pedagogical skills of the teacher in organizing this type of activity, goal setting, motivation of students, features of the organization of independent work, including the use of innovations, taking into account individual characteristics and the level of previously acquired knowledge and the level of development of independent work skills.

To effectively organize the independent work of students in the process of studying computer science, it is necessary to comply with certain methodological requirements, namely: defining the goals of independent work, taking into account the professional orientation of the pedagogical HEI; taking into account the general principles of higher education didactics, ECTS principles, personality-oriented, competence-based and activity-based approaches to learning.

The design of students' independent work in computer science should take into account the specifics of first-year students, taking into account their age, psychological readiness for this type of activity, and focus on professional orientation (training of future mathematics teachers).

The volume of independent work is regulated by the curriculum of the future teacher's training, drawn up in accordance with the educational program in which the student is studying. As for the content of independent work in computer science, it should be determined by the working curriculum and the needs of future pedagogical activity, which are set by the professional standard of the teacher and the requirements of the present.

When studying computer science, the teacher's activities in organizing independent work should help the student to create an individual educational trajectory. This will stimulate the formation of skills to determine the goals of their activities, the sequence of tasks, independently organise work and exercise self-control and reflection. Under such conditions, there will be an active development of key competencies and professional qualities of the applicant, as well as the formation of self-education skills. Such activities of the teacher are key to adhering to the principles of person-centred and competence-based approaches to learning and to the fundamentalisation of the concept of «lifelong learning».

An important role in the organization of independent work of students belongs to the correct selection of organizational and methodological support by the teacher. Here, it is advisable to highlight information and methodological support (Moodle distance learning environment, university repository, platforms with massive open online courses, etc.) and control and diagnostic support, which includes services for creating interactive exercises, tests and quizzes.

The introduction of active methods and forms of organization and control of independent work into the educational process, the development of its organizational and methodological support, the use of innovative teaching technologies, including information and communication technologies, project method and gamification technology, will help students develop the ability to work with information, starting with searching using various sources, develop their skills of independent planning and organization of the learning process, which will ensure the transition to continuing education (self-education) and after graduation, will help to form the key and professional competencies of a future specialist, which will allow him or her to be effective in further professional activities.

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