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Training of future primary school and computer science teachers in the structure of information systems

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Abstract. The active renewal of teacher education is driven by the contradiction between the need for new specialists and the lack of a clear strategy for modernising the educational process. The purpose of this study was to highlight all aspects of the process of training future primary school and computer science teachers to implement digital systems in conjunction with pedagogical conditions. The study employed such research methods as comparison, synthesis, observation, analysis, and abstraction. The key findings suggest that Ukraine is undergoing educational reforms aimed at updating the content and improving teaching and learning methods. The study covered the objectives, content, methods, forms, means of teaching the discipline "Computer Science (Structure and Main Components of Information Systems)" studied by future primary school and computer science teachers who undergo their professional training in the educational programmes 013 "Primary Education and Computer Science", 014 "Secondary Education (Labour Training and Technologies. Computer Science)" at Oleksandr Dovzhenko Hlukhiv National Pedagogical University. The study analysed the latest publications on the subject matter of the study. Based on the analysis of the possibilities and concrete potentials of using information technologies, the expediency of their introduction into personal and professional development of future primary school specialists was determined, the principal conditions for their use and for the developed teacher in the educational information system were highlighted. The study highlighted the content of classes aimed at developing information and communication skills and other key competences of future primary school and computer science teachers in studying the subject "Computer Science (Structure and main components of information systems)". The conclusions of this study state that the methodological recommendations for the organisation of practical classes in the course provide pedagogical

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support to teachers and contribute to the creation of a favourable learning and cognitive atmosphere during training. The practical significance of this study is to build a qualitative model that aims to improve the training future primary school and computer science teachers to implement digital systems in conjunction with pedagogical conditions

Keywords: information and communication competence; IT system; primary education personnel training; data processing; training model

INTRODUCTION

In the context of rapid development of the global information infrastructure, digital technologies play a major role in the advancement of Ukraine's socio-economic environment. Digital transformation, globalisation, and absence of information barriers between countries contribute to the active implementation of the latest scientific and technical achievements in the field of information and communication in education. Computers have become essential tools in all key areas of human activity, and therefore modern pedagogical specialists must be oriented in this rapid information flow. Notably, primary school is undergoing considerable changes, one of the main reasons for which is the introduction of digital technologies into the educational process. This creates opportunities to improve the level and quality of students' knowledge, as well as to develop modern skills and competences, such as information and digital ones, and those related to foreign languages and entrepreneurship.

The introduction of innovative teaching methods is becoming increasingly necessary thanks to the latest technologies. The use of these technologies in primary schools not only contributes to the success of Ukraine's new schools, but also makes learning more flexible and personalised. This gives teachers new opportunities to interact with their students and enjoy an exciting learning experience (Ihnatenko, 2023). Even though the topic of training future primary school teachers and computer science is widely studied and discussed by researchers in different countries, there are still issues that need to be addressed. G. Nugent *et al.* (2022) discusses a professional development (PD) program for elementary school teachers to improve their computer science (CS) knowledge and skills. Teaching a high-level programming language, merging CS topic and pedagogy education, and enlisting experienced K-12 CS teachers and university faculty as instructors were important components of the curriculum. T. Holovatenko (2023) emphasises the value of mobile learning in teaching digital natives in primary school at the same time. The researcher offers a range of mobile-device-based activities that support visual and digital literacies while encouraging student autonomy, teamwork, and critical thinking. These activities include the use of images, audio, and QR codes. According to K. Kim & K. Kwon (2023), teachers felt least confident about their subject understanding, with technological and pedagogical expertise of artificial intelligence coming in close second. Five

major themes in AI education were found from interviews with thirteen teachers: emphasising instructional design, revamping the classroom, lowering anxiety levels among educators, growing computer science-based AI education, and developing a literate understanding of data, code, AI technology, and moral dilemmas. According to S. Sularso *et al.* (2024), the use of computer music technology in the classroom has had a wide range of effects on teaching strategies, classroom dynamics, and student learning. The shift in classroom dynamics, characterised by increased collaboration among students and personalised instruction, demonstrates how technology can transform music education. Early results from a research involving four elementary-level teachers who took part in a collaborative professional development program in addition to a seven-lesson computer science instructional unit were given by C. Stephens *et al.* (2021). The findings indicate that the collaborative PD and expansive framing approach were effective in supporting elementary teachers' understanding and implementation of the CS instructional unit. M. Bers (2021) and S. Alhazbi (2023) note that all primary school teachers should specialise in computer technology. Accordingly, more support is needed in terms of improving the pedagogical content of education and knowledge about information systems. L. Kindei *et al.* (2022) agree that successful training of future teachers in modern conditions has a substantial impact on informatisation of the educational process and focuses on the active use of information technology tools.

There are also scientific studies that point to the insufficient level of scientific teaching, the lack of experimental nature of teaching new information and communication technologies (ICTs). G. Nugent *et al.* (2022) notes that modern teachers are insufficiently prepared in scientific and pedagogical terms, and there is a need to focus on high-level competences needed to solve practical problems or to apply scientific knowledge in everyday situations. At the same time, Y. Xiang *et al.* (2021) note that information systems are currently developing rapidly, specifically in the areas of mobile technology, the Internet of Things, and artificial intelligence. S. Sularso *et al.* (2024) further explore this idea, finding that digital pedagogical systems that use interactive software, collaborative projects, gamified learning experiences and, accordingly, allow each higher education student to take an active part in learning, creating a dynamic and inclusive environment. All this requires

constant reform of the content and methodological techniques for training future primary school specialists.

I. Storjak *et al.* (2022) helped to conceptualise how the interaction of digital technology, artificial intelligence (AI), and programming can help educators avoid inconsistent experiences. The most successful educational tools for working with students should be highlighted. In line with this, a pilot study on the use of AI by E. Southgate *et al.* (2022) showed that the creation of educational content for younger students by future primary school teachers had a considerable potential for positive learning outcomes, but only if time and organisational constraints were eliminated. N.V. Olefirenko *et al.* (2020) point out the need to constantly update the system of teaching information technology skills in educational institutions. This is a common concern for scientists and businesses in many industries. The content level includes the integration and development of courses and projects, improving the quality of the learning process, collecting and selecting high-quality learning resources, managing and creating learning environments inside and outside the educational institution, and creating a multidimensional assessment system.

The purpose of this study was to highlight the problems of training future primary school and computer science teachers studying under the educational programmes 013 “Primary Education and Computer Science”, 014 “Secondary Education (Labour Training and Technology. Computer Science)” in the structure of information systems. In line with this purpose, the following tasks were identified:

- to cover the theoretical information on the methodology of teaching the features of information systems;
- to identify the structure, principles of operation, characteristics of the hardware components of a personal computer;
- to provide methodological recommendations for the organisation of practical classes in the course “Computer Science (Structure and Main Components of Information Systems)”.

MATERIALS AND METHODS

The analysis of the curricula for bachelors majoring in Primary Education at Oleksandr Dovzhenko Hlukhiv National Pedagogical University at the beginning of the study reflects a wide range of professionally oriented disciplines, as well as skills in the subject application of ICT, which can develop information and communication competence as a key one. Scientific research, analysis of the Single treasury account (n.d.), Bachelor of Primary Education programmes, the new edition of the State Standard of Primary Education, surveys of teachers and university experience have revealed the need to improve a range of components of the system of training future primary school teachers (Ihnatenko, 2023). The study analysed regulations, including Law of Ukraine No. 1556-VII “On Higher Education” (2014), Resolution of the Cabinet of Ministers of Ukraine No. 87-2018-p “On Approval of the State Standard of Primary Education” (2018), Order of the Ministry of Economic Develop-

ment, Trade and Rural Affairs of Ukraine No. 2736-20 “On Approval of the Professional Standard for the Professions of Primary School Teacher of a General Secondary Education Institution, Teacher of a General Secondary Education Institution, Teacher of Primary Education (With a Junior Specialist Diploma)” (2020).

According to preschool and primary education and based on the analysis of scientific literature, results of international research and teaching practice, a model of primary school teachers’ training for teaching future primary school teachers and computer science teachers the structure of information systems was developed. The model covers all stages of the educational process at universities, including the use of information and communication technologies, and forms an integral part of this process. Nevertheless, as already mentioned, old approaches to the use of ICTs no longer have the psychological and pedagogical features that are necessary for modern students and do not meet important educational expectations. Accordingly, new requirements and developments of modern courses are being put forward.

The model includes the following steps:

- subject – a set of knowledge, skills and abilities related to the subject content of the Steps to Informatisation course. The following competences are particularly important: a set of methodological, didactic skills, and knowledge of the relevant parts and topics of the subject; experience in applying certain stages of learning in practice; ability to effectively solve problematic and standard methodological tasks;
- students’ ability to organise the use of ICT;
- self-education is a personality quality of a successful teacher that develops competences and is characterised by readiness for continuous professional education. This is crucial in the context of the continuous and rapid development of ICT and the continuity of the vocational education system.

In the presented model, the methodological system of training future primary school teachers to teach the fundamentals of digital technologies is considered as a set of basic means and goals of education, methods, content, forms that allow applying the selected content and achieving the designated purpose. To formulate the system of competences necessary for teaching students the basics of information and communication technologies, the educational and qualification requirements for primary school teachers were analysed (Holovatenko, 2023), the learning objectives were defined, the methodology for selecting the content of learning is described, and the methods, forms, and means of learning were identified.

Therefore, the choice of research methodology was aimed at identifying the most complete and objective characteristics of the problem under study in terms of quality training of future primary school and computer science teachers in the structure of information systems. Generally, it is believed that the combination of materials and methods underlying the methodology of this study is optimised in terms of achieving its objectives and can be effectively used in the learning process.

RESULTS

In the context of informatised education, to adapt to the needs of society, the implementation of conventional learning requirements requires the prerequisites of scientificity, visibility, accessibility, problematic nature, systematic, and sequential learning, activity. The consciousness of students in the educational process, the intensity of knowledge acquisition, the development of education and training, and the integration of educational functions have reached a new level. These requirements can be well fulfilled by involving knowledge-based information systems in the learning process.

The use of information technology in the training of real professionals is defined as an integrated approach to identifying the basics, creating and implementing learning processes involving people, tools, methods aimed at motivated, active work (Sapanca *et al.*, 2022). The task of higher education teachers is to provide consultations and identify prospects for the use of relevant technologies, and the task of future primary school teachers is to acknowledge the need to acquire skills, knowledge, and successfully apply them in their practical work. The use of ICT in the organisation of primary school teachers' professional activities has two aspects. The first one is related to the use of ICT tools for organising teacher's professional activity at all stages of lesson creation and delivery, the second one is the use of new tools for organising teacher's extracurricular professional activity (creation of teaching and learning materials for students, creation of structure and organisation); for materials for teachers (Morse, 2004; Morais *et al.*, 2005).

Resolution of the Cabinet of Ministers of Ukraine No. 87-2018-p (2018) in Ukraine defines IT education as one of the key areas in the curriculum of a modern school and sets clear requirements for the mandatory learning outcomes and competences of students. The main purpose of this field is to develop information and communication competencies and key skills necessary for solving problems using digital devices and ICT. It promotes personal growth, creative expression, as well as personal and social well-being, and develops skills of safe and ethical behaviour in the information society.

The stages of training future primary school teachers include the use of digital tools in teaching primary school children, description and analysis of successful curricula and relevant software and methodological support (Kager & Marinšek, 2023). Higher education teachers should draw the attention of future primary school teachers to the fact that, at the heart of teaching, everyone must adapt to the

conditions of particular software and hardware, considering the primary school curriculum, younger students, and their developmental levels. It is necessary to guide students through a systematic analysis of the curriculum, which is explained by the fact that they need to clearly understand the status and role of a particular curriculum in the entire structure of education. Proceeding from the principles of analysing the methodological framework and content of computer science courses, it is impossible not to draw the attention of higher education students to their multidimensionality (Huang & Meng, 2022). Forming in their minds a vision of the triple goals of the processes of education, training and development of individuals is considered an essential stage of preparation for practical work. The training is mainly about spreading the basic concepts of computer science (information, algorithms) and developing project management skills, as well as the factual areas in which children receive (consolidation, repetition) of knowledge in other subjects (digital skills, number composition, word grammar analysis) in each lesson.

The discipline "Computer Science (Structure and Main Components of Information Systems)" provides information on digital technology, the structure of modern personal computers, peripherals, computer networks, preparation of presentations, organisation of group work using online services, organisation of video conferences with the introduction of distance learning. Future specialists are provided with expert support. The effectiveness of training future professionals depends on a range of factors, including the reliability of the equipment and software used, the interests of students, their ability to use remote information resources, computer skills, and motivation to use digital learning tools (Law of Ukraine No. 1556-VII, 2014). The use of digital learning tools by primary school teachers in the educational process is conditioned by the current level of education in primary general education and the principles of the New Ukrainian School (NUS). This is reflected in the professional standards for teachers, which emphasise the reasonable use of digital tools "according to the needs and objectives of professional activity". It is noted that the use of digital learning tools should not only be dominant, but also auxiliary and must be combined with other teaching methods and forms of education (Order of the Ministry of Economic Development, Trade and Rural Affairs of Ukraine No. 2736-20, 2020). The analysis of the elements of information and communication technologies in educational activities is presented in Table 1.

Table 1. ICT elements of primary school teachers' readiness to teach the fundamentals of computer science

ICT elements							
Methodological		Theoretical		Psychological		Practical	
Specialised knowledge	Psychological and pedagogical skills	Knowledge system in information disciplines	Motivational (emotional and volitional, and goal-oriented)	Orientation-based	Evaluation and result-based	Creative	Content and operational-based

Source: compiled by the authors

The introduction of the educational process and the constant use of knowledge-intensive information systems in it to assess the quality of mastering the set goals, their creation and production requires certain changes in the educational process, namely:

- teachers as expert consultants in the educational process;
- transferring part of the training materials to students for self-study;
- development of educational and methodological complexes considering the specifics of knowledge-intensive information systems for educational purposes;
- gradual abandonment of the conventional form of control and introduction of the role of individual indicators of accumulation, milestones, and current;
- final analysis of the acquisition of skills and knowledge.

Particular attention should be paid to the use of knowledge-based information systems to implement adaptive learning management. Thus, in the modern sense and in a broader sense, adaptation means not only the ability to adapt to function successfully in a certain environment, but also the ability to further develop psychological, personal, and social abilities in this environment. When creating an adaptive educational environment, it is also important to adapt to the conditions of the internal environment, i.e., the intellectual, emotional, evaluative, and behavioural spheres of each person involved in the educational process. However, a crucial feature of adaptability is the development of the ability to improve oneself, considering one's age, internal resources, and abilities. The introduction of the concepts of adaptive management of the educational system, based mainly on the provisions of modern theoretical

foundations of management and psychotherapy, provides prospects for transformation from a dogmatic and authoritarian educational system to the creation of a favourable educational system.

The training of applicants for education in the speciality of primary education and computer science is carried out under the educational programme 013 "Primary Education and Computer Science". As a result of its successful completion, students receive the following qualification: "Bachelor of Primary Education. Primary school teacher at a general secondary education institution. Primary school computer science teacher at a general secondary education institution". Future teachers of computer science are also trained at the first (bachelor's) level of higher education in the speciality 014 "Secondary Education (Vocational Training and Technology)", field of knowledge 01 Education/Pedagogy under the educational programme "Secondary Education (Vocational Training and Technology. Computer Science)". As a result of its completion, students receive a qualification: "Bachelor of Secondary Education (Vocational Education and Technology)". Students majoring in Primary Education and Computer Science consider the structure of information systems when studying the course "Computer Science (Structure and Main Components of Information Systems)", which is a mandatory component of these educational programmes, and which is allocated 4 credits of the European Credit Transfer and Accumulation System (ECTS). The above-mentioned educational programmes require the use of an improved educational model that defines the stages of the educational process in higher education institutions based on the use of ICT, which is ultimately a necessary part of this process (Fig. 1).

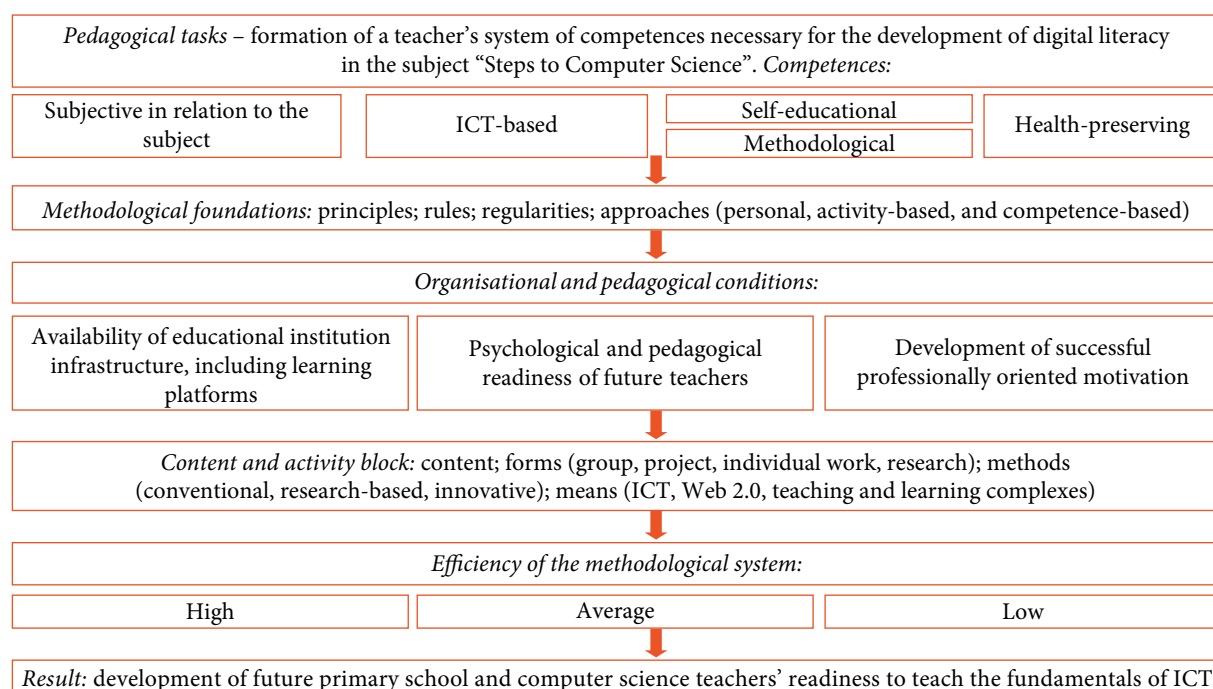


Figure 1. A model for preparing future primary school teachers for teaching fundamentals of information and communication technologies

Source: compiled by the authors

After studying the discipline “Computer Science (Structure and Main Components of Information Systems)”, future teachers should master the following: understanding of the concept of an information system, their types and main characteristics; knowledge of the architecture of a personal computer and the principles of its operation; ability to apply the acquired knowledge in further professional activities; information on the types of computer networks and the principles of their construction; understanding of the structure of a personal computer (PC), its main characteristics and functional purpose of its components (central processor, motherboard, RAM, storage devices, input and output devices).

Upon completion of the educational components, each applicant should acquire the following general competences: nationhood (liberal democracy) is the ability to understand the values of society and the need for its continuous development, to recognise the rule of law, human and civil rights and freedoms, and to exercise one's responsibilities and rights as a member of society; to multiply and preserve cultural, moral, and scientific achievements, achievements of society based on an understanding of historical periods and patterns of development of the subject area, its place in the general system of knowledge about society and nature, as well as its place in social, technical and technological development; introduction of relevant forms and types of physical activity for a healthy lifestyle; assessing and ensuring the quality of work performed; work in teams; finding, solving, or formulating problems; searching, processing, and analysing certain information from various sources; practice in a socially conscious and responsible manner; work following ethical considerations.

In organising the educational process, preference is given to innovative forms of classes and methods of teaching, learning, and assessment. According to the Order of the Ministry of Economic Development, Trade and Rural Affairs of Ukraine No. 2736-20 (2020) and Resolution of the Cabinet of Ministers of Ukraine No. 87-2018-p (2018), innovations are changes or improvements that relate to competitive technologies, services, products, as well as organisational and technical solutions in production, administrative, commercial, or other areas of activity. These innovations are distinguished by their focus on substantially improving the quality and structure of production, as well as the social sphere. Research and innovation play a key role in developing the economy, enhancing the country's competitiveness, and improving the quality of life.

A range of teaching methods are used to teach this discipline. Verbal methods: explanation: providing information in the form of verbal comments to help learners understand concepts or processes; narration: a teacher's retelling of a story or material for the purpose of teaching; conversation: a discussion of a given topic between a teacher and students, aimed at active involvement of each; instruction: explaining procedures or rules for performing certain tasks. Visual methods: demonstration: showing real objects or processes to better understand the material; illustration: the use of images, diagrams, or charts to visualise concepts or information. Practical methods: observation:

the process of actively perceiving information through the observation of real situations; experiment: conducting controlled research to study certain phenomena or patterns; exercises: practical exercises or tasks aimed at consolidating knowledge and skills; practical work: an activity that includes practical skills and application of knowledge in a given area; work with information sources: searching, analysing, and using information from various sources for educational purposes; data analysis: processing and interpreting information to draw insights and conclusions.

The following types of evaluation are distinguished for monitoring and control. The oral form of assessment includes interviews, defence of laboratory works, presentations, and comments on the reference notes. These forms facilitate active interaction between the teacher and the student and allow assessing the level of understanding and comprehension of the material.

The written assessment method includes independent work according to the options, completion of an individual task, filling in a table, drafting a diagram, performing relevant exercises. These types of assessments allow assessing the degree of independence, understanding and comprehension of the material by the learner. The test form of assessment includes closed-question tests, matching tests, sequencing tests. These methods allow quickly and objectively assessing the level of mastery of particular knowledge and skills. Self-monitoring involves self-assessment of written work and other tasks. This method promotes active involvement of students in their own learning and development of self-regulation. The final control is carried out in the form of a test, which assesses the overall level of mastery of the educational material by the student and their readiness for further study or work in this field. The system of assessment of students' learning achievements in the discipline “Computer Science (Structure and Main Components of Information Systems)” is based on competence-based approaches aimed at forming the relevant achievements of the programme learning outcome in the future specialist. This approach involves not only the acquisition of theoretical knowledge but also the development of practical skills necessary for successful professional activity.

The students' academic achievements in this discipline are assessed using a module-rating system based on the principle of cooperative reporting. This means that the grade is formed not only based on a single exam or test, but also based on the results of various activities during the academic period, such as independent work, practical work, projects, and other assignments. Furthermore, the assessment system makes provision for mandatory module control, which makes it possible to systematically check the level of learning at each stage of learning. A cumulative system of assessment of the level of skills, knowledge, and abilities allows students to gradually improve their results and track their progress throughout the learning process. It is worth considering the basic theoretical information offered to students in the course “Computer Science (Structure and Main Components of Information Systems)”. The entire course is divided into 7 content modules, which include lectures, practical work, and independent work of the

student (Ihnatenko, 2022). During the first topic, students consider the concept of systems, information systems, their types and characteristics, history of development, examples of control systems, sign systems, ordinary languages as an example of a sign system, formal languages, programming languages. It is recommended that this material be studied in the form of a reference lecture and self-study material.

In the second lecture, students consider: a computer as an information system, the architecture of a personal computer, the functional diagram and principles of a modern computer. Basic concepts to be formed: computer as an information system, software interface, hardware interface, software, principles of computer operation, functional diagram, main-module principle of computer structure, principles of numerical data encoding, computer structural diagram, main components of computer hardware. The third topic is the structure, main characteristics, and functional purpose of the central processor, motherboard, and RAM. Key concepts: central processor, processor parameters, RAM, motherboard, ROM. The fourth topic is the structure and main characteristics of modern data storage devices. Key concepts: data storage media, punch cards, floppy disks and discs of various formats, hard disc drives, solid-state drives. The fifth topic is the structure, main characteristics, and functional purpose of information input devices. Key concepts: data input devices, keyboard, mouse, scanners of various types, microphones, game manipulators, graphics tablets, webcams. The sixth topic is the structure, main characteristics, and functional purpose of information output devices. Key concepts: monitors and their characteristics, types of matrices, printers and their types, multimedia projectors and their types. The final, seventh topic is computer networks, types and principles of construction. Key concepts: computer networks, their classification, technologies and equipment for organising computer networks, the Internet, data transfer protocols, modem operation, domain, domain zones. According to the theoretical information described above, students are offered to complete practical classes in the course "Computer Science (Structure and Basic Components of Information Systems)". The plan of each practical lesson consists of a topic, an objective, questions for discussion, a practical task, and test questions. Let us take a closer look at the methodology for conducting practical classes.

Topic of the practical session No. 1: "Computer central processing unit".

Purpose: To get to know the device "central processing unit". Consider the functional purpose, main types, and key characteristics of a computer's central processing unit.

Questions for discussion:

1. What is a computer's central processing unit?
2. The history of processor development.
3. Key features of processors.
4. World leaders in processor manufacturing.
5. Development prospects for processors.
6. Selecting a central processor depending on the task at hand.

Control questions:

1. What is computer architecture?
2. How do computer processors differ depending on the generation?
3. What are the main characteristics of computer processors?
4. What is the purpose of the computer processor cache?
5. What is a TCP processor?

The effectiveness of a computer science lesson depends on the correct selection of its type with a certain relevant structure of constituent elements. The choice of the form of teaching is influenced by the place of each lesson in the thematic logic of the subject, the purpose of the lesson, content, and tasks, age characteristics of students, students' experience. Today, there are the following types of lessons: introductory lessons (introduction to the topic), lessons on recognising the essence of the terminology of the topic and identifying important thematic patterns, lessons on repetition and generalisation, and practical lessons.

The lesson of acquiring new knowledge includes the acquisition of knowledge includes their perception, recognition, understanding of internal relations and dependencies of objects and phenomena, memorisation, generalisation, systematisation. Success in acquiring knowledge depends on the goals and motivation of the students and the teacher. With this in mind, this type of lesson includes the following elements: homework review, background knowledge, and review. The basis for designing the structure of such lessons is the pedagogical system of exercises and tasks, as well as their sequence, which contributes to the achievement of the educational purpose. Following the logic of the process, the lessons of mastering skills and abilities include repeating homework, using skills and abilities, applying new knowledge (test practice). This lesson involves independent application of knowledge in typical situations (diagrams, instructions, task-based training exercises) and creative transfer of knowledge and skills to new situations (creative exercises), lesson summary, homework assignment.

The lesson is designed to confirm knowledge, skills, and abilities. Depending on the purpose of the lesson, the content of the educational material, methods and means of teaching, the structure of this type of lesson varies. This knowledge, skills at various levels, from determining students' knowledge of factual material to formulating concepts to reveal a system of knowledge and applying this knowledge creatively in non-standard conditions, includes competence testing. In this approach, the structure of the lesson includes: a message about the topics, goals and objectives of the lessons, and motivation for learning. Combined lessons have several equivalent learning objectives, and the structure varies depending on which type of lesson and its components are combined. For instance, the structure of a learning unit that combines a review of what students have already learned. Furthermore, the acquisition of new knowledge may include communicating the topics, goals, and objectives of the unit, motivating learning,

review, assessment, reconstruction, modification of prior knowledge, recognition, understanding, generalisation, and systematisation of new knowledge, lesson summaries and homework assignments.

Therefore, in a competence-based methodological system, the training of a future computer science teacher includes revision of learning goals and objectives, considering the development of students' skills in different types of lessons, independent use of knowledge in professional activities at the level of established professional requirements and responsible performance of professional duties. The specificity of pedagogical activity and skills of primary school and computer science teachers, recognition of its social significance and personal responsibility for the results of this activity determine the continuity of the formation and development of professional abilities throughout life. In the context of distance learning, students are asked to prepare a report and develop a presentation on the issues discussed in preparation for practical classes. Students upload the prepared reports, e.g., to Google Classroom for review. One can defend their work during video conferences in Zoom or Google Meet. During online classes, it is recommended not only to listen to students' reports, but also to initiate discussions and debates on problematic issues.

Based on the coverage of theoretical information on the methodology of teaching the features of information systems, it was possible to systematise and summarise the key aspects of learning, which contributes to more effective learning of the material by higher education students. The definition of the structure, principles of operation and characteristics of the hardware components of a personal computer allowed students to improve their understanding of the principles of functioning and interconnection of information system components. The provided methodological recommendations for organising practical classes in the course provide pedagogical support to teachers and contribute to the creation of a favourable learning and cognitive atmosphere during classes. This includes the use of modern methods and techniques, active involvement of students in practical tasks, and interaction with educational materials. This approach helps to improve the quality of education and prepare students for real-world challenges in the field of information technology.

DISCUSSION

The discussion of the development and practical training of future primary school and computer science teachers in the structure of information systems allows comparing the findings of this study with the results of scientists conducting research in this area. This issue is a subject of much thought and debate and has been investigated many times using a variety of approaches.

Specifically, the opinion of L. Kindei *et al.* (2021) coincides with that of the author of this study and determines that the specific feature of teaching computer science in primary school is that it is unclear who is better suited to teach this subject to primary school children: primary

school teachers who do not have sufficient subject matter competence but are familiar with psychology, developmental levels, and other aspects of teaching primary school children, or computer science teachers who have sufficient subject matter knowledge but little experience of working with primary school children. An essential feature of teaching younger students is considering their age, physiological, and mental characteristics. This is crucial when teaching such complex subjects as computer science. It was found that the most difficult part of organising a course to prepare teachers for teaching computer science in primary education is the readiness of teachers for this type of educational activity. The format and methods of work during the course help prepare teachers for practical work with computers, but it is important to pay attention to the software and learning tools available in schools and suitable for teaching primary school children. These ideas are also reflected by J. Parham-Mocello *et al.* (2023), who noted that one of the main conditions for introducing computer science into the primary school educational process is the training of a new generation of teachers who are familiar with the technical characteristics of computers, strictly adhere to the rules and regulations of computer hygiene, are familiar with computer programs specially designed for students, are aware of the ethical rules of their use, and are familiar with innovative technologies. All of them recognise that the challenge is to train a new generation of teachers who are proficient in the methodology of using educational technologies.

Considering the views of researchers such as C.C. Chang *et al.* (2022), and L. El-Hamamsy *et al.* (2021), the use of information technology in the training of vocational education specialists can be interpreted as a comprehensive approach to the definition, development, and implementation of vocational education. This is an educational process that includes the function of personal, instrumental, and methodological means aimed at motivated and active acquisition of skills, knowledge, and abilities related to the optimised use of information technology in future activities. Future primary school teachers are faced with the task of demonstrating the potential of using information technology, acknowledging the significance of the knowledge and skills they have acquired and successfully applying them in their future professional activities. The opinions of D.D. Oh *et al.* (2024) and M. Fundi *et al.* (2024) on the organisation of primary school teachers' professional activities using ICT partially support the initial hypotheses of the author of this study. It should be added that this training is manifested in various aspects, namely, one is relevant to the organisation of qualified teacher activities at the stage of preparation and implementation of lessons using ICT tools; the other is related to the organisation of the use of innovative tools, the organisation of extracurricular professional activities of teachers (preparation of didactic materials for students and methodological and organisational materials for teachers).

On the one hand, M. Fundi *et al.* (2024) defines that one of the stages of training qualified primary school teachers

to use computers in teaching younger students is the characterisation and analysis of alternative curricula, relevant software, and methodological software. Teachers of pedagogical faculties should draw the attention of their students, future primary school teachers, to the fact that pedagogical practice should accommodate the curriculum of primary school children and their developmental level, each of which should be adapted to concrete programme and technical requirements. In other words, they should guide students to a systematic analysis of the learning process, i.e., to a clear understanding of the place and role of a particular lesson in the overall structure of learning. This is the only way to ensure that the material is correctly remembered and repeated. Following the principles of systematic analysis of the content and methodological foundations of the computer science course, one should draw students' attention to its multifaceted nature. Forming a vision of the three objectives of the course – to teach, up-bring, and develop – is of great importance as a preparatory stage for their implementation. On the other hand, T. Holovatenko (2023) suggests that teaching should encourage the development of fundamental computer science concepts (knowledge, algorithms) and programme management skills. Specifically, it is vital to ensure that in each lesson children learn material from other lessons (counting, number structure, grammatical analysis of words). From the very first lesson, a future primary school and computer science teacher should try to form an appropriate attitude towards computers in children. The above ideas of M. Fundi *et al.* (2024) and T. Holovatenko (2023) clearly reflect the significance of highlighting research findings.

M. Worsley (2022) complements the findings of the present study and addresses the development of practical exercises. At the initial stages of methodological training, it is important to teach students how to plan lessons. Both exemplary and imperfect lessons should be recorded on video and subsequently analysed: the structure of the lesson, the content of the non-computer part, and the relevance to the training software. This applies to the choice of organisational forms and methods, ways to control the quality of learning, and the emotional colouring of lessons and student activities. Experience shows that this type of training is positive. This is because issues often arise that have not been previously addressed in the classroom, such as knowledge control, consideration of individual characteristics of students when organising independent work with a computer, didactic principles of computer-based learning, and ways to maintain motivation to learn. Teachers and methodologists should also constantly remind students that a prerequisite for using computers in primary school is compliance with hygiene and sanitary requirements to protect the physical and mental health of young students. It was found that the use of ICT tools in future professional activities is an overall quality of a person characterised by knowledge, skills, abilities, qualities, and the ability to use these tools creatively in future professional activities. It is reflected in the intellectual, motivational, subject matter,

and practical spheres of a person's activity. The readiness of future primary school teachers to use ICT tools in their professional activities as a range of interrelated motivational, operational, affective-volitional, evaluative-reflective, and reflective criteria (Sinha *et al.*, 2023; Levitt *et al.*, 2024). Proceeding from the above criteria, the author of this study has further improved the information on the degree of readiness to use each digital technology tool in business activities, which can be divided into three levels.

1. The prominent level of readiness includes students who are purposeful, deeply aware of the need for pedagogical training, and are characterised by a desire for creative and search activities to improve their knowledge and professional skills. Such students demonstrate a positive and active attitude towards learning how to implement ICT in the educational and training process.

2. A sufficient level of future teachers' readiness to implement IT tools is characterised by the presence of active motivation to learn and work. Such students consciously fulfil the teacher's tasks in the classroom and in extracurricular activities, but do not show activity and creativity. They clearly recognise the activities that they find more important and interesting. In situations where students are not confident in their knowledge and skills, they do not show readiness to overcome problems.

3. The low level of readiness is reflected in weak positive motivation and low value of professional and educational activities using information systems. Cognitive interest is mostly short-term and situational.

These studies emphasise the significance of computer training for future teachers, specifically, teaching them to use ICT effectively in their professional activities. There is also a need to develop students' practical skills, increase their readiness to use these tools and consider hygiene and sanitary aspects when introducing ICTs into the educational process.

CONCLUSIONS

Consideration of the selection, development, and implementation of advanced technologies, models, and learning systems in Ukrainian higher education should be based on a thorough and comprehensive analysis of current trends, patterns of social life, achievements of Ukrainian and world philosophy, psychology and pedagogy, experience of methodologists and practitioners. The results of this analysis helped to identify relevant changes and promising ways to reform and improve the Ukrainian research and education system. It can be argued that the principal vector of teacher education development is a fundamental change in its content, which is focused on improving the quality of training teachers with professional knowledge, capable of replenishing it independently, and being competitive in the market of educational services. According to the analysis of the main studies devoted to determining the content of preparation for the professional activity of future computer science teachers, the development of professional competence of a teacher includes in-depth knowledge of the subject, teaching methods, pedagogy, psychology, didactics,

and pedagogical skills related to the teacher's behaviour in various pedagogical situations. It can also be concluded that it includes the development and formation of the necessary personal qualities, communication skills, the need for self-improvement and self-esteem.

The study considered the elements of the methodology for training students of higher pedagogical education institutions majoring in 013 "Primary Education and Computer Science", 014 "Secondary Education (Labour Training and Technology. Computer Science)" on the structure of information systems in studying the course "Computer Science (Structure and Main Components of Information Systems)". The theoretical information on the features of information systems; structure, principles of operation, characteristics of hardware components of a personal computer; methodological recommendations for practical work were presented. The findings of the study suggest that the introduction of innovations in the learning process plays a considerable role in the development of education, increasing the country's competitiveness and improving the quality of life of each future specialist. In the educational process in the discipline "Computer Science (Structure and Main Components of Information Systems)", it was found that various teaching methods are used, such as verbal, practical, and visual methods, which are aimed at developing students' competences. The basis for assessing students' academic achievements is a competence-based approach that involves not only the acquisition of theoretical knowledge but also the development of practical skills necessary for

successful professional activity. The assessment system is based on a module-rating system, which helps to objectively determine the level of learning and encourages students to work systematically throughout the entire academic period. Therefore, considering the significance of innovations in the modern educational environment, the course "Computer Science (Structure and Main Components of Information Systems)" sets standards of high-quality education and contributes to the training of qualified specialists in the field of information technology.

The findings of this study are limited to the analysis of the development of information and communication skills and other key competences of future primary school and computer science teachers while studying the subject "Computer Science (Structure and Main Components of Information Systems)". The scope of this study was limited to a single higher education institution where the study was conducted. Further areas for research include the development and testing of innovative training programmes for future teachers who teach computer science in primary schools, and the study of the use of the latest technologies, such as artificial intelligence or virtual reality, in professional training.

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CONFLICT OF INTEREST

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Підготовка майбутніх учителів початкової школи та інформатики з будови інформаційних систем

Анотація. Активне оновлення педагогічної освіти зумовлено протиріччям між потребою у нових фахівцях та відсутністю чіткої стратегії модернізації освітнього процесу. Метою статті було виокремлення всіх аспектів процесу підготовки майбутніх учителів початкової школи та інформатики до реалізації цифрових систем в сукупності з педагогічними умовами. У роботі використано такі методи дослідження, як порівняння, синтез, спостереження, аналіз, абстрагування, порівняння. В основних результатах виявлено, що в Україні відбуваються реформи у сфері освіти, спрямовані на оновлення змісту та вдосконалення методів викладання і навчання. У статті розкрито цілі, зміст, методи, форми, засоби навчання дисципліни «Інформатика (Будова та основні складові інформаційних систем)», що вивчається майбутніми вчителями початкової школи та інформатики, які здійснюють свою фахову підготовку за освітніми програмами 013 «Початкова освіта та інформатика», 014 «Середня освіта (Трудове навчання та технології. Інформатика)» у Глухівському національному педагогічному університеті імені Олександра Довженка. Здійснено аналіз останніх публікацій з проблематики дослідження. На основі аналізу можливостей і конкретних потенціалів використання інформаційних технологій з'ясовано доцільність їх впровадження у процес особистісно-професійного розвитку майбутніх фахівців початкової школи, виділено основні умови їх використання та сформованого педагога в освітній інформаційній системі. Висвітлено зміст занять, направлених на розвиток інформаційно-комунікаційних навичок та інших ключових компетентностей майбутніх викладачів початкової школи та інформатики, під час вивчення навчального предмету «Інформатика (Будова та основні складові інформаційних систем)». У висновках зазначено, що методичні рекомендації до організації практичних занять з курсу забезпечують педагогічну підтримку викладачам та сприяють створенню сприятливої навчально-пізнавальної атмосфери під час навчання. Практичне значення роботи полягає у побудові якісної моделі, що має на меті покращити процес підготовки майбутніх учителів початкової школи та інформатики до реалізації цифрових систем в сукупності з педагогічними умовами.

Ключові слова: інформаційно-комунікаційна компетентність; ІТ-система; підготовка кадрів початкової освіти; обробка даних; модель навчання