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THE THEORETICAL AND METHODOLOGICAL BASES FOR THE PROFESSIONAL TRAINING OF A PRIMARY SCHOOL TEACHER TO TEACHING COMPUTER SCIENCE

Abstract: The rapid growth of information and communication technologies makes the qualitative update of the demands towards the informatization of education on all of its levels relevant. The examination of the philosophical aspects of the development of computer science enables one to understand the continuity and prospective viability of the processes that take place in the society and education. The introduction of computer science to the curriculums influenced the social demand for a primary school teacher capable not only of using the means of information technologies, but also of teaching computer science as an independent primary school discipline. The article gives reasons for the necessity to develop the corresponding methodological system of training the future primary school teacher, its functions and components. We see the expected result as the formation of methodological and informatics competence of the teacher.

INTRODUCTION

The thematic justification of researching the problem of forming the readiness of a future primary school teacher to teaching computer science is grounded upon a number of factors which can be conventionally divided into those connected to the development of the society and the corresponding social request for its IT-competent members; the transformation of the subject matter of education, specifically primary education; the structural and content changes in the process of training a primary school teacher.

The denoted factors let us single out the following contradictions:

- between the amplification of the influence of information and communicative technology regarding the formation of key and ICT-competencies among children and the absence of the methodological system of training a primary school teacher to teach computer science in higher education establishments;

- between current requirements for professional training of a primary school teacher which make their ICT- and methodological competencies and the absence of the uniform theoretical, methodological, and normative bases for the formation of said competencies, the measurement criteria of such qualities among the graduate students, relevant.

We see the resolution of the noted contradictions in the theoretical development of the methodological system of training the primary school teacher to teach primary school pupils computer science, with the professional competencies of the said teacher corresponding to the challenges of the current information society and allowing a young specialist to realize themselves in dynamically changing conditions. The methodological system which contains interconnected components — the aim, the subject matter, the methods, the means, the forms of organizing activity — allows one to plan, realize, monitor and correct the training of a primary school teacher for teaching primary school pupils computer science at each stage with the possibility of forecasting the intermediate and final results.

The theoretical and methodological bases of the research are:

- the concept of the systemic analysis of social processes, events, and objects (P. Anokhin, I. Blauberg, K. Boulding, B.Lomov, W. Ashby);
- the concept of the informatization of education (M. Zhaldak, K. Kolin, Y. Mashbyts', V. Monakhov, M. Lapchyk, I. Robert);
- the concept of the technologization of teaching (V. Bespal'ko, V. Monakhov, M. Klarin, A. Khutorskoy);
- the methodological, didactical, methodical researches of training future primary school teachers (A. Kolomiyets', L. Petukhova, O. Savchenko).

1. THE PHILOSOPHICAL ASPECT OF THE INFORMATIZATION OF EDUCATION

The problem of perception, processing, systematization of the information, its encoding and the possibilities of storing it in various forms hearkens back to the age of primitive people.

People gained the full-fledged ability to express, transmit information with the appearance of speech. For example, the development of speech contributed to the development of the channels of information perception, transmission, and storage,, allowing to distribute one's knowledge, life experience etc. But the distribution of knowledge outside of the circle of the primitive society was further complicated both by differences in the languages of neighboring tribes and the loss of information media (for instance, war chiefs, the elderly generation).

The appearance of signs carved in trees, pictures carved in rocks, knots on cords etc. contributed to the appearance of such medium and means of human speech transmission as writing systems. The spoken word, the information were reflected in signs, symbols. This way, the opportunity not only to transmit, but also to store information, came into existence. More than 7 millennia after that first written documents appeared, which are divided by scientists into various classes, depending on what elements of the language are transmitted with the help of signs (phraseological, logographic, ideographic, morphemographic writing system, etc.)

Focusing specifically on graphic attributes alone, we should note that pictography transmits information with the help of pictures, or pictograms, hieroglyphic systems (Egyptian, Chinese) use hieroglyphs, cuneiform (Sumer, Babylon) use special dash-like notes, linear writing systems rely upon the conventional combinations of straight and rounded lines (Ancient Greek, Latin, Cyrillic script).

So it can be observed that having transcended rock pictures, symbolic notes on crockery, papyrus, clay and stone tablets, humanity has started using scripts (notably, Latin script) since early Middle Ages as the means to transfer and store information.

Solving the next problem, connected with the distribution of the information and the opportunity of its dissemination within a wide circle of people, gave rise to the development of printing. Wikipedia defines printing as the process of creating printed products that appeared, according to some sources, in China in 581 AD, or, according to other sources, between 936 and 993 AD[1].

In the 19th century the radio, the telephone and the telegraph become new means of transferring information. Such inventions as the telegraph, the telephone, and the radio dramatically increased the possibilities of transferring and disseminating information in time as well as in space.

For instance, the telegraph (from Ancient Greek “τῆλε” — “far away” + γράφω — “I write”) — the means of transferring the signal via wires or other channels of electric connection — was first demonstrated in 1860.

The invention of the telephone (from Greek “tele” — “far away” and “phone” — “voice”) — the device to transfer sound to long distances with the help of electrical signals — dates back to 1876.

The authorship of radio as the area of science and technology connected to the transmission of high-frequency electromagnetic waves to varied distances, or radiowaves, which enable the radio broadcasts of signals, speech, music for an unlimited number of listeners, was contested among many inventors. However, 1893 is officially the year when the radio was established.

In 1946 humanity received its first electronic computing device, and the end of the 20th century was defined by the rapid development of computer-related technology.

Therefore, humanity in its development has gone through at least 3 information revolutions. A revolution or an explosion, according to the teaching of philosophers, happens due to at least three factors: the unity and conflict of opposites (the conflict gives rise to changes and explains the reasons for growth), the transition from quantity to new quality (the accumulation of quantitative changes results in qualitative changes), the negation of negation (each next period of development denies the previous one, explaining the direction of development).

The first information revolution was the word which is the means of transferring information. The symbol as the means of transferring and storing the information became the second information revolution. The digital code used by the electronic devices became the third one.

The researchers define the stages humanity has gone through on its way to informatization, stressing the fact that, upon reaching each stage, the amounts of information transferred, processed, and stored, grew dramatically (fig. 1.).

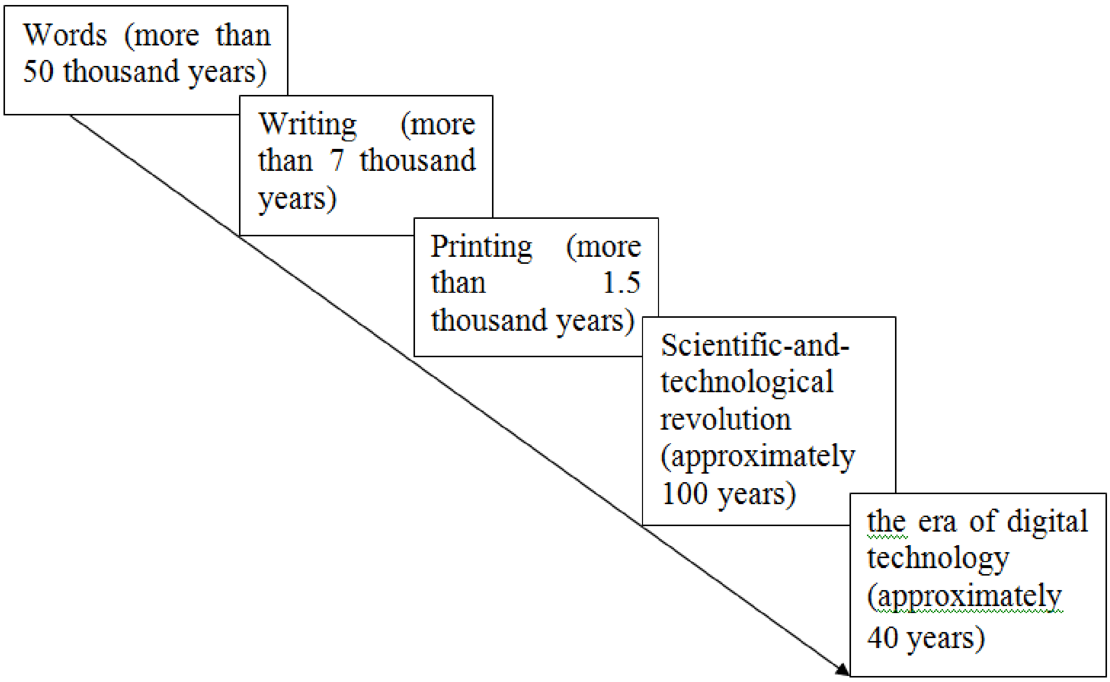

Fig. 1. – The stages of informatization

The irreversibility of the elecronic technology development process lies in the appearance of brand new possibilities that existed never before and the rapid loss of relevance for the old ones. Modern information technology has the unlimited power of spreading and the potential for development.

The directionality of the information means development process lies in the movement of objects and systems along pre-defined trajectories: physical miniaturization, increasing functional capabilities, the operational efficiency of actions etc. This quality is expresses in collecting and using new knowledge which is the base for further development of information technology.

Surely, any change taken into account, legacy elements are kept at the next level of development, albeit with new qualities. For example, the computing device of any generation has a processor, information input/output devices, different kinds of memory etc. within its structure. Since the moment when the first computer technology appeared its physical charactreistics have changed substantially (the decrease in size and weight, the increase in the speed of processing and the amount of information etc.), but at its core there is still the architecture proposed by John von Neumann and realized in the first computers.

Since the process of development is impossible without the existence of internal and external contradictions within a system, we should establish what determines the development of the information technology. First of all, it's a contradiction between new kinds of technology and those technical capabilities new means were built upon; between the advantages and disadvantages of the means of information technology (for example, power and high energy consumption); the contradiction between technical tasks and technical capabilities, between software and hardware etc.[2].

The development occurs in time — from the past, through the present, into the future. The acceleration of the pace of life can be observed in practically every aspect of human activity. For instance, the time between the occurrence of the invention and its adoption was: for paper — 1000 years; steam engine — 80; telephone — 50; airplane — 20; transistor devices — 3 years; wave transmission — 1 year; lasers — half a year; fax machines — only 3 months... [3,p.87]. Modern gadgets are updated monthly.

This tendency is also traced in the development of the information technology means: the cutting-edge computer devices become obsolete in half a year; the time to transmit messages has practically dropped down to zero. The increase in tcomputer quantity, the impovement of their functionality, the availability of information — all of this has led to total dependency upon the means of communication. The ripenng of prerequisites for the next information revolution in the development of the society is obvious.

The researches of K. K. Kolin [4] bear evidence of this revolution being different from the previous ones in terms of its matter as well as its consequences. In his surveys the scientist stresses the most important differences that have major influence on the infomatization of the society, namely: the penetration of information technology into all aspects of human life and activity; the globalization of the information environment of the world community through the information communications; the transformation of the information into the most important category of economy; the spreading of digital devices and digital technology beyond the information branch of the society; the global opportunities to use cognitive information technology for the development of intellectual and creative abilities of a human; the forming of the information-centered worldview which substantially changes the traditional material and energetic view of the world, the scientific paradigm and the methodology of scientific research; the emerging of previously unknown, new complex of information security problems [5].

Because the pace of information development of the civilization exceeds the speed of its reflection in the conscience of mankind, the problem of acceping and using the opportunities given by information and communication technologies is relevant.

In fact, the development processes in the area of artificial intelligence advance very rapidly. And this is natural, because, as R. Descartes said, the mind is defined by three main characterisics: the amount of memory, the quantity and the set of logical operations, and also the speed of performing said operations. These three characteristics which are a basis for the functioning of computers, have long surpassed human capabilities. Therefore, solving the problem of self-programming challenges the principal difference between the cognition of man and machine [6].

The existence of electronic devices pushed forward the development of such domain as informatics. The object of informatics is information processes in nature and society, as well as information technology.

The philosophical understanding of information as the objective reality of the world around us is substantiated by V. Glushkov, B. Goldstein, I. Gurevich, G. Klaus, B. Kadomtsev, V. Sanochkin, A. Turing, A. Ursul, S. Hessing, Y. Shemakin, R. Yusupov and others [7;8].

The scientists single out matter, energy and information as the variants of manifestation of the objective reality. Hence the modern interpretation of information: it is a physical substance which characterizes the state and the character of the matter or energy motion. Both matter and energy are information media.

Luciano Floridi, the professor of Hertfordshire University (UK) in his research works substantiates the emerging of a new philosophical discipline — philosophy of information. In his opinion, the development of computer devices and technology originate a new philosophical paradigm, the new interpretation of such basic philosophical concepts as “knowledge”, “experience”, “truth”, “ethics”, “creativity” [9].

The philosophy of information explains the nature and the principles of information, including its dynamics (especially calculations and data streams) and use; shows the directions for the development of theoretical methodologies regarding information.

L. Floridi makes the problem of updating the traditional philosophical theory relevant due to the development and spreading of the information and communication technologies and states 18 problems of information philosophy which he divides into 5 groups: the analysis of information as the central concept; semantics; the study of intelligence or understanding; the relations between nature and information; the examination of values.

One of the scientist's conclusions is picturing the world as the symbiosis of humans, artificial agents, and ordinary items constantly communicating with each other with the help of wireless connection. Such computerization, in the words of L. Floridi, will make the surrounding world almost living a life of its own, i.e., the present difference between being online and offline in cyberspace will disappear [10].

K. Kolin offers a hypothesis about the information unity of the world, according to which "there are some fundamental regularites of the information manifestation, which are common for the information processes and are relized in the objects, processes, and phenomena of any nature. The study of these very regularities has to become one of the most important tasks of informatics as the fundamental science. This is the essence of its interdisciplinary role within the system of scientific knowledge" [11, C. 97].

By this line of reasoning, computer science, expanding its borders outside the domain of technology, is transformed into the instrument of cognition and the development of natural, humanitarian, social problems. Which determines the necessity of taking the philosophical bases of informatics into account within the system of education and science.

2. THE SCIENTIFIC, SOCIAL, PEDAGOGICAL PROBLEMATICS OF METHODOLOGICAL AND INFORMATIC TRAINING OF A PRIMARY SCHOOL TEACHER

It is believed, that the word "informatics" comes from the portmanteau of "information" and "automatics". Though there were little to no scholarly debates about the name of the science, the views upon its subject changed over time, influenced by the rapid development of scientific and technical progress in this domain.

In this sense, the meaningful interpretations of informatics are those given by the academician A. Yershov, who is believed to be the founder of this science in the post-Soviet space. In 1983 he defined informatics as the knowledge put into action by computers [12], in 1984 — as a fundamental natural sience which studies the processes of transmitting and processing information [13], and in 1985 — as the science "about the laws and methods of gathering, transmitting and processing information — the knowledge we receive" [14].

In 1990 K. Kolin defined the subject of informatics as a science as "the properties, patterns, methods and means of forming information..., its representation, quantitative evaluation, storage, transformation and dissemination in nature and society, and also the problems of creating respective technical systems for this purpose" [15,C. 23].

Mathematics, cybernetics, systems engineering, electronics, logic, and linguistics became parent sciences for informatics. Currently, the main schools of informatics are the theoretical bases of computing devices, the statistical theory of information, the theory of mathematical modeling and computational experiment, the algorithmization, programming, artificial intelligence and informology which studies the communication processes and the dissemination of information in social systems.

In English-speaking countries the term "Informatics" is replaced by the terms "Computer Science" or "Information Science". The object domain of informatics is divided into 4 branches:

- theoretical informatics,
- means of informatization;
- information technology;
- social informatics.

Today the effectiveness of research works in the domain of informatics is greater than that of most scientific and educational branches, and wide implementation of the results allows it to be defined as the interdisciplinary science about information and the processes of informational interaction in nature and society.

The informatization of education, according to the words of S. Goncharenko, is "a complex of social and pedagogical transformations, connected with the systems of education being saturated with information products, means, and technology... The informatization of education is a part of the process of society informatization, the theoretical basis for which is provided by informatics — the system of knowledge concerning the production, transformation, storage, search and redistribution of information in its most diverse aspects in nature, society, the technosphere” [16, p. 149].

The methodology, theory, and practice of the education informatization were developed by such scientists as D. Bell, Z. Brzeziński, V. Bykov, N. Wiener, V. Glushkov, M. Zhaldak, A. Yershov, M. Lapchyk, V. Monakhov et al.

A. Kolomiyets’, M. Levshyn, D. Mazokha, L. Makarenko, N. Morze, L. Petukhova, Y. Smyrnova-Trybul’s’ka, O. Sukhovirs’ky, I. Shaposhnikova, O. Shyman et al have chosen one of the directions of their research to be the problem of forming the information competency of the future primary school teacher as the personal complex which integrates the knowledge about main methods of informatics and information technology, the ability to use the means of information and communication technology, the readiness and ability to use this technology effectively in one’s scientific and professional activity.

Due to the changes of the strategic directions of education — the orientation on activity approach and the formation of important life competencies among school pupils — the Concept of new Ukrainian school is developed and is being implemented, the content of learning Informatics in secondary schools is updated.

This brings relevance to structural and content changes in the process of training a primary school teacher, specifically concerning teaching informatics, which is not only a fundamental science in this day and age, but also an instrument to form key, domain-specific and interdisciplinary competencies of primary school pupils.

What is an issue is not only the formation of informatic competency of a future primary teacher, but also him being equipped with methodological knowledge, abilities, skills, the experience of relevant activities. The uniqueness of the system of training the future primary school teacher to teach primary school pupils informatics is determined by a whole range of regularities, among which we single out the following ones:

- high level of demands concerning the quality of teaching primary school pupils informatics;
- the lack of specialists ready to the wide use of the information technology means and high-quality teaching of informatics in primary grades;
- the pace of informatization of society and education influence the necessity for the constant upgrade of the methodological support for the disciplines related to informatics and the methodology of informatics in higher educational establishments [17].

The above prove the relevance of the solution to a number of problems, which include the following:

• The object competence of a graduate of the Faculty of Pedagogy does not ensure the possibility of forming within him/her an appropriate level of teaching computer science in elementary classes (insufficient level of basic informatics training, the change of requirements for professional competencies, undeveloped methodical system of training the primary school teacher to teach computer science);

• Insufficient level of pedagogical training of graduates for their independent professional activities regarding teaching primary school pupils informatics.

• The creation of a flexible model of the future primary school teacher with a high level of formation of methodological and informational competency, competitive in the labor market [17].

Thus, it is possible to highlight the methodological aspects that should become the basis for determining the content and components of the methodological and informational competence of the teacher: first of all, the methodological and informational competence of the teacher is a component of his professional competence, and its structure is determined by the directions of professional methodological and informational activities of the teacher. Secondly, the selection of an array of professional methodological and informational tasks, which the teacher must solve, will allow the formation of a list of norms and requirements for the methodological and informational training of the teacher, which in turn will allow monitoring the formation of methodological and informational competence.

The methodological and informational competence of the teacher is manifested in his activity, which is associated with the execution of various functions. We consider it expedient to outline the functions of the studied formation.

The axiological (from the ancient Greek, ἀξία - value) function of the methodological and informational competence of the elementary school teacher is to justify those values that direct a person to specific actions and motivate to actualize the goals and content in accordance with the requirements of professional and educational standards. It is about the awareness of the influence of the informatization process on personality, since the experience of all information revolutions testifies to their impossibility without the society adopting the necessity of qualitative transformations in the system of education. The modern development of the information society actualizes the problem of the transformation of the informational literacy of a primary school child through the information culture to the information worldview, the formation of which depends on the methodological and informational competence of the teacher.

The gnoseological (from ancient Greek. Γνωστικός - cognition) function is to construct a system of objective knowledge of information processes, their properties, means and methods of their dissemination. The formation of methodological and informational competence equips the primary school teacher with the knowledge about the structure of a highly developed information society, the conditions for using its resources and development principles. The uniqueness of this function lies in the fact that the very rapid development of information and communication technology requires constant transformation of methodological and informational competence of the teacher.

The praxiological (from Ancient Greek πράξις - activity) function is about studying the professional activity of the teacher (substantive, pedagogical, social, etc. work) in the information and communication environment. This function involves obtaining practical experience of known methods of pedagogical activity, materialized in information-communication, instrumental, constructive skills.

The prognostic (from the Greek prо́gnosis - prediction) function is aimed at solving the problems of the teacher planning their own methodological activities, as well as prediction and forecasting of its results. The constant updating of knowledge in the field of information and communication technology will impact the relevance of the search for qualitatively new forms and methods of working with pupils. Thus, in extracurricular activities in the field of informatics, the organization of web quests, project activity in chats, the use of modern graphic editors to create animation objects and so on became commonplace.

A teacher with a high level of the formation of methodological and informational competence, possessing relevant contemporary knowledge in the industry, is capable of predicting the intellectual and practical demands of pupils and the corresponding organization of teaching informatics.

The prognostic function is responsible for timely reaction to outdated knowledge and the emergence of new ones, which allows forecasting trends in the development of information and communication technologies and the methodical aspects of their use. The main tool of this function is monitoring, as the system of selection, processing, analysis and storage of information, which provides for the possibility of timely correction of the investigated process and prediction of its further development.

The reflexive (from the Latin reflexio - reversal) function directs the teacher to form his/her own methodological activity, to realize the need to improve the acquired competencies. The reflexive function in a certain way is an indicator of the theoretical, practical and methodological training of a teacher in the field of operating the means of information technology and training primary school pupils to use them. їх використання молодшими школярами. In a way, it is also about mastering the personal meaning of pedagogical activity, the desire for self-perfection, a sense of responsibility and professional growth.

3. THE METHODOLOGICAL SYSTEM OF FORMING THE INFORMATION AND METHODOLOGICAL COMPETENCY OF A PRIMARY SCHOOL TEACHER

According to the functions necessary to achieve the planned educational outcomes, we will design the appropriate methodological system.

In the research works of A. Pyshkalo the methodological system is presented as the unity of such elements as the goals, content, forms, methods and means of teaching the discipline [18].

N. Stefanova determines the methodological system as a model of educational process, the components of which are goals, content, methods, forms, means and expected results [19].

In any case, the methodological system should contain the following components that outline the guidelines for the functioning of the system, ensure the efficiency and optimality of its operation.

Based on the technology of designing the educational process by V. Monakhov, the theoretical component of the methodological system of training a primary school teacher to teach informatics can be seen as a model of this system, the components of which are:

- motivational, as the need for continuous updating of knowledge in the field of information technology, the analysis of one's own capabilities, the ability for self-esteem, etc.
- Cognitive, based on knowledge in the field of information and communication technology, the awareness of the issues of informatics didactics and the organization of educational work in primary school, establishing content relationships that provide for continuous vocational education.
- Activity-based, based on the practical implementation of knowledge formed within the cognitive component, that is, updating experience, developing flexibility and adaptability to continuous change.
- Professional and pedagogical, which is based on one's own pedagogical activity using the means of information and communication technology and teaching computer science and in primary school.

The purpose of the outlined methodological system is the formation of methodological and informational competence in the future primary school teacher, which we define as a systemic personal quality, which reflects his/her knowledge and skills in the field of information and communication technology, in the issues regarding didactics of informatics and the organization of educational work in primary grades, value attitude towards one's own professional activity, motivation for self-perfection and professional growth [17].

We are projecting the expected result in the form of a competency model of the future primary school teacher regarding his/her preparation for successfuly completing the primary school tasks dealing with informatics and the methodology of informatics.

Let's determine the qualitative characteristics of such educational result. First, it is *operational capacity* that allows one to use the knowledge and skills to solve one's own educational tasks and in different types of activities: educational, quasi-professional, and professional.

The second characteristic we highlight is *self-education*, which consists in the ability of the future teacher not only to navigate in the fast-moving changes taking place in the information society and regulate the updating of norms and requirements in the field of informatics education at all its stages, but also to improve one's own level of the formation of methodological and informational competence.

The third characteristic is *metadisciplinarity*. It is about the ability to apply informatics skills in various activities, in the process of mastering (teaching) various disciplines, to enrich the methodological support of the educational process of primary school through the implementation of information and communication technologies.

Thus, all the characteristics of the educational result are subject to the analysis in order to determine the level of formation of the investigated competence. It makes the creation and use of appropriate diagnostic tools that take into account the quality of student's educational activities, self-analysis of the success of learning, the effectiveness of self-education, relevant.

Cognitive, activity, vocational and pedagogical components are realized through the students mastering the following courses: "Fundamentals of Informatics with the Elements of Programming", "Methodology of Teaching Informatics in Elementary Schools", "Modern Information Technologies of Learning", "Information Technology Management in Educational Institutions " — on the basis of psychological and pedagogical disciplines and the methodology of primary school education.

In accordance with the content, the methods, forms and means of teaching are defined, the directions of pedagogical practice are expanded. In addition to the traditional tools of content implementation, we offer the following as organizational forms of teaching:

- lectures with preliminary acquaintance of their content, which allows one to focus on the discussion of "key" moments within the lecture time;
- seminars on which projects are being developed and presented as a result of interaction within a group;
- Optional courses: "Robotics", "Technology of design activities of the teacher";
- pedagogical practice as a cutting-edge element of the system.

The developed teaching aids are supplemented by educational materials available on the Internet, which optimizes the individual work of students.

The compulsory element of a designed methodological system of training a future primary school teacher to teach informatics is the monitoring of achievements with the correction of results.

CONCLUSION

The proposed model of training a future primary school teacher to teach informatics is flexible and, according to the philosophy of informatics, it requires quite frequent revision and rework.

In our opinion, the components most sensitive to changes in this model are the cognitive and activity components. This is explained by the fact that the continuous development of the information and communication environment affects the transformation of informatics-related knowledge and skills of its participants, causing the need to update the content of the relevant educational branch at all of its levels.

For example, the widespread use of electronic maps, navigation tools; environments for virtual tours or excursions, etc. prompted scholars to include relevant topics in curricula, in particular, the curriculum of informatics in primary schools. Naturally, updating the contents of textbooks and manuals for both school and higher education is not performed at a desirable rate. There is problem of high-quality coverage of this topic for both primary school pupils and for students — future primary school teachers. In both cases, the previous level of readiness for teaching computer science becomes irrelevant and requires motivational and reflexive efforts from the teacher as well as responses from scientists and methodologists in terms of content.

Thus, the specificity of the methodological and informational training of the future primary school teacher is that the constant transformation of the requirements to one of its components, the informatics-related one, demands corresponding improvements to another one — methodological. And since informatics competence is simultaneously general and professional, there are objective preconditions for its improvement throughout life.

Within the framework of providing higher education at the faculties, which provide the training of primary school teachers, the problem of creating a flexible information and communication educational environment, coherence of disciplines within the educational program, development and functioning of the methodical system of such training is becoming more and more relevant. At the all-Ukrainian level, a need was expressed to create a methodological portal, the scientific and methodological administration of which is carried out by scientists in the field of methodology of teaching informatics, authors of curricula, etc.

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