PREPARATION OF FUTURE PHYSICS TEACHERS FOR THE FORMATION OF STUDENTS' RESEARCH COMPETENCE

Abstract. In the article a systemic approach to application of multimedia aimed at forming methodic competence of future physics teachers is elaborated and proposed. Based on the competency approach, methods of teaching physics to pedagogical university students with the use of multimedia were worked out and offered for practical application. Considering methodic competency as a component of professional training, the current state of methodic readiness of a physics teacher under conditions of the credit based modular learning was reviewed. The idea of implementing multimedia into training process is reviewed from the standpoints of psychology and pedagogy, nature and didactic opportunities of training information media-visualization, ergonomic and psychophysiological requirements to its representation when teaching physics and methods of teaching it to students majoring in physics. Within two-stage training of physics teachers the procedure of applying multimedia when forming subject competency while studying general and theoretical physics at lectures, practicals, and self-guided work with educational material, techniques and ways of academic performance rating under conditions of the credit based modular learning were proposed. Implementation of the proposed procedure is put into practice partially in modern textbooks, which combine book and electronic versions of the content as illustrated by the chapters “Oscillations and Waves”, “Methods of Teaching Physics. General Issues”. The proposed didactic system of applying multimedia in methodic training of future physics teachers is based on the integral approach to studying general issues of teaching physics, systemic approach to forming basic notions of school course of physics with the use of the developed dynamic computer models and forming teaching and methodic abilities to apply knowledge, abilities and skills in teaching practice at the comprehensive school.
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ПІДГОТОВКА МАЙБУТНІХ УЧИТЕЛІВ ФІЗИКИ ДО ФОРМУВАННЯ ДОСЛІДНИЦЬКОЇ КОМПЕТЕНТНОСТІ УЧНІВ

Анотація. У роботі розроблено й обґрунтовано технологію реалізації концепції методичної компетентності на засадах застосування мультимедіа як сукупності предметної, психолого-педагогічної, інформаційно-технологічної та комунікативної компонент, які визначають модуля знань, практичних умінь, контролю та корекції знань, організації позакласної та позаурочної роботи. З метою адаптації першокурсників до форм і методів навчання в університеті пропонуємо вивчення узагальнених питань шкільного курсу фізики. З психологічної точки зору таке пригадування навчального матеріалу не є поверненням до параграфів шкільного підручника, оскільки пропонується вивчення дедуктивним методом. З іншого боку, мотиви гідності для колишніх випускників школи очевидна через низький рівень знань з фізики, відсутність ключових умінь – формулювати закони, давати визначення фізичної величини, встановлювати одиницю її вимірювання тощо.

Визначено, що практика викладання показує, що курс фізики втрачає сенс без демонстрацій, що зміцнюють експериментальну основу фізичної науки.

Доведено, що комплексне поєднання кібернетичних інформаційних систем, спрямованих учитеlem на об’єкт навчання, з класичним способом формування понять сприяє компетентнісній підготовці майбутнього вчителя фізики та дозволяє створити модель діяльності вчителя, спрямовану на управління саморозвитком особистості. психічних процесів та мотивація учнів до вивчення фізики. Навчання студентів методам розв’язування фізичних задач є важливим напрямком їх предметної підготовки. Уміння та вміння розв’язувати фізичні задачі є яскравим показником повноти та глибини знань з предмета, їх системності та міцності.

Ключові слова: методика навчання фізики, методична компетентність, дидактична система навчання фізики, методична підготовка, мультимедіа під час навчання фізики, демонстраційні комп’ютерні моделі, мультимедійні додатки з фізики.
Formulation of the problem. The direction of Ukrainian education in the European educational space, along with the requirements for the professional readiness of a graduate of a pedagogical university, requires an adequate competence approach to the development of a new state standard of education (bachelor's, master's), the content of programs, textbooks and manuals for professional training of higher school students for professional activities. The purpose of the study is to theoretically substantiate and propose didactic principles for the formation of methodological competence of the future physics teacher based on the use of multimedia tools and teaching methods.

The subject of the research is the didactic foundations of the formation of the methodological competence of the future physics teacher in the conditions of using multimedia tools and teaching methods.

Analysis of research and publications. The implementation of the credit-module system is an important factor for stimulating the effective work of the teacher and the student, increasing the time of their direct individual communication during education. Along with this, from the strategic point of view of the development of higher education, it is envisaged to educate students in a responsible attitude to learning, a desire for constant self-education, self-development and self-improvement. The modular presentation of the content of the academic discipline requires deep analytical work on the contextual content of the discipline, structuring it as a system, and not arbitrary collection of scientific information. It makes it possible to highlight the general cross-cutting ideas of professional activity, which each module is aimed at revealing and assimilating [1–6].

The modular system of organizing the educational process is aimed at increasing the activity and independence of students, creates conditions for choosing one's own (personal) individual trajectory of mastering an educational discipline in terms of content, pace, time frames, forms of mastering and methods of monitoring achievements. We consider the modular structure of the educational discipline as a component of the educational environment, which in its essence is a dialectical combination of spatial-objective, social and technological components, which are interconnected and mutually conditioned by each other. An important role in the competence training of the future physics teacher is played by the complex use of modern didactic teaching tools, in particular multimedia, in combination with traditional methods. At the same time, the effectiveness of the development of thinking and the formation of motivation for educational and cognitive activities are directed during the teaching of physics according to the principle "from general to concrete", and the use of visual aids - according to the principle "from abstract to concrete".

If the general theoretical issues of the competence approach are thoroughly developed in the works of V. Baidenko, S. Honcharenko, V. Ilchenko, O. Lyashenko, E. Korshak, O. Ovcharuk, O. Savchenko, A. Khutorsky, etc., then its implementation
in preparation future physics teacher is in the process of formation. The introduction of interactive teaching methods into the educational process requires the development of a methodology for the use of innovative technologies for training a highly qualified specialist. Within the framework of the formation of methodological competence of future physics teachers, the modular structure is built on the principles of providing subject training in physics and its teaching methods in close connection with psychological and pedagogical disciplines and information technologies.

**The purpose and objectives of the article.** The purpose of our research is the process of training a future physics teacher at a pedagogical university during the training of professional disciplines. To justify the technology of implementing the concepts of methodical competence on the basis of the application of multimedia as a set of subject, psychological-pedagogical, information-technological and communicative components, which determine the modules of knowledge, practical skills, control and correction of knowledge, organization of extracurricular and extracurricular work.

**Summary of the research results.** Psychological and pedagogical principles of the use of multimedia during the teaching of physics and its teaching methods. From the standpoint of determining the effective impact of the use of multimedia tools in the methodical training system of future physics teachers, the essence and didactic possibilities of multimedia visualization of educational information, ergonomic and psychological-physiological bases of presentation of multimedia-organized information, didactic aspects of learning using multimedia tools, forms of organization of learning in higher education are considered institution in the conditions of informatization of education and educational multimedia resources on physics and its teaching methods for higher schools.

Multimedia visualization should be considered such a presentation of educational information, in which its content is conveyed mainly by visual and audio images in combination with hypertext in an interactive aesthetic and emotional form. The main didactic unit of multimedia visualization of educational information is a visual-sound image or multimedia illustration. We consider the audio-visual image in several contexts. From a technical point of view, it is actual digitized data about the object of study on an electronic medium, which is reproduced on a monitor screen or a demonstration screen in the form of images of objects of study. From a psychological and pedagogical point of view, this is a sensual form of presentation of educational content, a presentation of a subjective reflection of objective reality mediated through a screen [7–9].

In this context, the main task of creating a visual-sound image consists in providing assistance to the student during the process of perception and mental creation in one's own mind of a visual mental image of the physical phenomenon or process being studied. A multimedia audio-visual image is a demonstration
computer model that acts as a substitute for the original (object, concept, process, phenomenon), reflects its important properties, serves to transmit knowledge about the original, to learn about its structure, properties, features, etc.

Multimedia visualization involves the realization of the didactic potential of multimedia technologies. First of all, it ensures compliance with the principle of visibility at a qualitatively new level thanks to the unity of conceptual and sensory, logical and emotional, concrete and abstract during learning. Multimedia visualization itself is an interactive composition of multimedia images and hypertext modeled for educational purposes. Its main properties are: flexibility, adaptability to the user, interactivity, cognitive, staged presentation of information, synthesized environment, etc.

The following components of multimedia visualization are distinguished: visual series, sound series, computer video. According to this classification, multimedia visualization tools belong to the type of educational multimedia presentations.

An educational multimedia presentation is a digital presentation of educational material in which the content of educational information is presented in the form of slides in an interactive multimedia form, which are united by a certain topic and a single design; the pace of the demonstration of which is controlled by the teacher, accompanying the video slides with comments, explanations, etc. Studying the phenomenon of educational multimedia in physics, we note its insufficient development from the standpoint of pedagogy, psychology, and teaching methods of physics.

When developing multimedia educational programs and ensuring their full-scale information saturation, it is necessary to provide for the maximum simplicity and transparency of organizing the study of educational material by a student or student. At the same time, it is expedient to create such a system of visual and sound images, which, having a complex effect on associative images and ideas, on the sight, hearing and imagination of the student (pupil), creates the necessary motivation for a better perception of the educational material. An essential feature of educational programs is that they include two types of activities - teaching and learning. In other words, when designing or constructing a curriculum, we foresee the activity of the teacher and the activity of the student. The creation of multimedia resources should be carried out in close cooperation between teachers-practitioners, scientists-pedagogues and programmer engineers, as a symbiosis of psychological-pedagogical, subject and technical components.

The use of multimedia during the theoretical generalizations of the school physics course in the system of forming the methodological competence of the future physics teacher is important from the standpoint of the need to systematize and generalize the knowledge of graduates of secondary educational institutions as a repetitive cycle of the school physics course at the highest level of perception, in
connection with the change of psychophysiological features of the transition from adolescence to youth.

As for the organization of lectures and practical classes, each of them is accompanied by multimedia presentations, which include video fragments of artistic and scientific films, video recordings of a physical experiment, diagrams, tables, and demonstration computer models. Thus, motivation is not created by the justification of the actual need to solve the educational problem, but by its very existence, the presence of a contradiction between the clear and the incomprehensible, the known and the unknown (partially known). In line with theoretical generalizations, the content of the educational material is presented in the form of theoretical schemes. By reproducing them, the student learns all types of activities for acquiring knowledge, learns to pronounce the definitions of physical quantities and their measurement units, formulate laws, principles, etc. It is important that auditory analyzers are involved in the activity during listening [10-15].

As one of the options, it is convenient to use demo computer models. In one of the modes, the student, perceiving video information, listens to the commentary, which is "used to" hearing scientific physical terminology. In the "teacher" mode, educational computer programs contain only slides, the student must make comments himself, which develops his speaking abilities.

This approach was used by us in the development of multimedia applications for lectures on the course of general physics (optics), methods of studying general and specific questions of the school physics course. For speech preparation of the future physics teacher, we suggest using physics texts, which are divided into the following differential types according to their educational purpose: text-summary, standard text (for analysis, imitation), text-schema, algorithm, instruction, etc.

A systematic approach to the formation of the subject competence of the future physics teacher on the basis of multimedia. Based on the systemic approach and the essence of person-oriented education, the author examines the didactic foundations of the formation of the subject competence of the future physics teacher in the conditions of two-level education. Studying a general physics course at a university provides three main groups of skills. The first group is mastery of the basic concepts of the science of physics and their adaptation to the level of the school physics course based on a deep understanding of the essence of these concepts. The second group is conducting experimental research from the course of general physics in laboratories and applying individual ideas and skills of working with laboratory equipment in a school physical experiment. The third group is actually the ability to solve problems from the general course of physics and school problems of any degree of complexity (including competitive problems).

The subject training of a physics teacher in pedagogical universities begins with the study of a general physics course. This course takes the first place in terms
of its importance in the system of studying physics, because it is the foundation on which all physical education is based.

The structure of the course is built so that the learning process is as close as possible to the process of scientific research. The main form of education in higher education is the lecture - the most effective way of communicating information, as it ensures optimal creative interaction between the lecturer and the listeners. During the lecture, within a short period of time, the student receives logical structured educational information on specific issues, gets acquainted with the ways and means of acquiring knowledge and its practical use. Thanks to the development of information technologies, taking into account additional psychological factors, we propose to significantly modernize the lecture form of teaching in order to increase the amount of educational material presented for consideration at lectures.

One of these forms of lectures is offered as a multimedia lecture, during which the primary assimilation of educational material is provided due to a complex combination of visual perception with verbal perception and the use of reference text notes. A student from a simple listener turns into an active viewer who observes, listens, takes certain notes, and actively participates in communication with the lecturer.

The teacher remains the main actor during the organization and conduct of the multimedia lecture. First, during the preparation for the lesson, taking into account the age and psychological-pedagogical characteristics of the relevant group of students, the lecturer chooses those multimedia tools that best serve to achieve the goals of a specific topic (section). Commenting on the submitted material, focusing attention on the main, most important issues, expressing one's own scientifically based opinion give the lecturer the opportunity to devote more time to communicating with students, identifying the incomprehensible, providing appropriate help and eliminating typical mistakes, applying techniques and methods of arousing interest and increasing interest in the study of physics as a science.

The presence of hyperlinks, dynamic computer animations, historical reference, fragments of video demonstrations of a natural experiment and computer models ensures an increase in the volume of educational material and the density of its presentation during a lecture session. Thus, educational information during the formation of theoretical knowledge about Fresnel zones in a multimedia presentation is presented on many slides and a system of hyperlinks, which in general reveal the essence of the phenomenon, help in understanding the mechanism of formation of zones and the application of the method of zones to explain the phenomenon of Fresnel and Fraunhofer diffraction.

In order to deepen the understanding of the mechanism of formation of a diffraction pattern and to establish dependencies and determine their influence on the observed pattern, we are completing the study of the phenomenon based on an interactive computer model, which in a controlled dynamic mode step by step
simulates the process of light propagation through a diffraction grating and refraction in a composite lens.

For example, a lecture is transformed into triads of (25+5) minutes each. Theoretical material is considered for 25 minutes, and blitz control in the form of test tasks is conducted for the next 5 minutes, for the completion of which students are assigned appropriate credit points. For a lecture duration of 80 minutes, we allocate 60 minutes (75%) of time to consider the issues of the information-theoretical part, 10 minutes (12.5%) of time to demonstrations (in-person or computer), diagnostic survey – 10 minutes (12.5%).

Multimedia simplifies the process of reproducing the known (Cartesian, polar coordinate systems) and considering new ones (cylindrical and spherical coordinate systems), establishing the relationship between the corresponding coordinates, etc. In the same active mode, the computer program assumes repetition of the methods of specifying the movement of a material point. During the study of Lagrange equations of the first and second kind as the basic principles of theoretical mechanics, the main attention is traditionally focused on equations of the second kind, while a less important part of the topic is left for independent study by students or is not considered at all in the course of theoretical mechanics of pedagogical universities. In the best case, more successful students, using scientific literature, will independently consider this question. However, there is a certain number of students whose level of preparation does not allow them to learn the Lagrange equation of the first kind on their own.

The didactic basis of the use of multimedia for the formation of methodological competence during the study of physics teaching methods is revealed by the didactic system of training a future physics teacher, which is based on an integrated approach to the study of general issues of physics teaching methods, a systematic approach to the formation of basic physical concepts of a school physics course by means of computer simulation, formation of readiness for the use of multimedia during the construction of physics lessons, conducting lessons on solving physical problems and developing experimental skills by combining multimedia and natural experiments. Techniques and ways of studying general questions of physics teaching methods using relevant multimedia applications proposed by the author are described.

Demonstration computer models serve as an important addition to the explanatory and illustrative teaching method. The starting points for their creation are based on facts known from physiology that the bandwidth of the human auditory analyzer (50 thousand bits/s) is much smaller than the visual one (5 million bits/s); activation of mental activity increases significantly as a result of clear perception, which involves a greater number of analyzers. The construction of such models is made taking into account the modern achievements of didactics and teaching methods of physics.
Teaching practice shows that a physics course loses its meaning without demonstrations that reinforce the experimental basis of physical science. For the purpose of complete coverage and comprehensive consideration of a certain physical phenomenon, we additionally use video recordings of a real physical demonstration and a computer demonstration model created on its basis. The first component provides a real physical situation, although it does not allow replacing the order of actions with devices; the second is variable - both in terms of content and didactic purposes of using it in the lesson. Together, this combination ensures the realism of the process under consideration, the ability to focus attention on the essential features of the phenomenon, meaningful understanding and formation of a physical concept.

The complex combination of cybernetic information systems directed by the teacher to the object of learning with the classical method of forming concepts contributes to the competence training of the future physics teacher and allows to create a model of the teacher's activity aimed at managing the self-development of mental processes and motivating students to study physics. Teaching students methods of solving physical problems is an important direction of their subject training. The skill and ability to solve physical problems is a vivid indicator of the completeness and depth of subject knowledge, its systematicity and strength.

Using available digital educational resources and developing their own multimedia models, students design fragments of physics problem-solving lessons during the laboratory work of the Physics Teaching Methodology course.

Multimedia tools significantly expand the possibilities of analyzing the received answer, the functional dependence of the sought value on known parameters from the condition of the problem. The work describes how to use the developed multimedia resource Graph Master to conduct research on functional dependencies and monitor the appearance of the function depending on the change of the argument in the video mode.

**Conclusions.** So, one of the final stages of the formation of the methodological competence of the future physics teacher is considered pedagogical practice, during which the student realizes his own readiness for future practical activities. The structure and content of pedagogy in terms of the step-by-step formation of the personality of a competent teacher is implemented as a set of propaedeutic (III-IV courses), research-reflective (IV course) and research-project (V course) stages. The attitude of students to the use of multimedia tools and teaching methods is expressed through the determination of the level of interest and the need for specific competencies in the field of multimedia. The results of the control of residual knowledge provide grounds for asserting that the use of the proposed methodology and technology for the formation of methodological competence during lecture, practical, seminar classes and independent work on the course of physics and its teaching methodology based on the use of multimedia
increases the level of knowledge, the formation of skills and the readiness of the future teacher of physics to conduct independent practical activities in educational institutions.

Quantitative analysis of the results of educational achievements of students from the course of general physics and teaching methods of physics, carried out by the methods of dispersion analysis and calculation of the Pearson test with a confidence probability of 0.96 based on the final control. Statistical processing of the results of experimental studies confirmed the hypothesis that the use of multimedia tools and methods of teaching future physics teachers has a sufficient influence on the level of knowledge of students in general and theoretical physics and methods of teaching physics, which are taught within the framework of the proposed didactic system, and the formation of methodological competence of the future physics teacher.

References:


Література:


