DEVELOPMENT OF INDEPENDENT COGNITIVE ACTIVITY OF HIGHER EDUCATION APPLICANTS IN TEACHING PHYSICS IN PEDAGOGICAL INSTITUTIONS OF HIGHER EDUCATION

Abstract. In the educational process and in modern psychological and pedagogical science, and especially in the didactics of physics, the problem of forming an active personality of applicants for higher education is one of the most important and relevant, which requires a solution at the present stage. The purpose of the research is to determine the most effective means of developing the cognitive activity of higher education applicants in physics classes in pedagogical institutions of higher education. The article analyzes the problems of the educational process in the course of general physics in domestic pedagogical institutions of higher education. A psychological and pedagogical analysis of the selected definitions and their types (activity, cognitive activity, educational activity, research activity, action, etc.) is carried out. The essence of the concept of “independent cognitive activity” is characterized. Attention is focused on the fact that the process of cognition in the field of physics, as well as the learning process, is carried out on the basis of integrated activities, which can be represented by its theoretical component, as well as an experimental component, which are equally important and significant. The types of activities in the methodology of teaching physics are considered: reproductive (which provides a solution to the problem in a well-known way, based on previous experience), productive (which manifests itself in the course of mastering new knowledge under new conditions) and creative (which differs from the previous ones by the presence of a qualitatively new element in solving the problem with a new result). The results of pedagogical research and their own vision of solving the problem of activating independent cognitive activity of higher education applicants in higher education institutions are presented: complex use of all available incentives, technologies, methodology, methods, techniques, teaching systems and tools, encouraging students to increase the level of activity, for example, from reproductive to creative or to factors that reflect: natural interest of learners (students) in the knowledge of natural phenomena, professional interest, increasing
the rating of higher education applicants in training, future career, the desire for self-improvement and self-development, taking into account the main psychological, pedagogical, organizational and methodological provisions that reflect a certain period or stage of development of both science and the educational field as a whole.

**Keywords:** independent cognitive activity, future teachers of physics, pedagogical institutions of higher education, the process of cognition, individualization of learning, learning technologies, research work, differentiation of learning.

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### РОЗВИТОК САМОСТІЙНОЇ ПІЗНАВАЛЬНОЇ ДІЯЛЬНОСТІ ЗДОБУВАЧІВ ВИЩОЇ ОСВІТИ В НАВЧАННІ ФІЗИКИ У ПЕДАГОГІЧНИХ ЗАКЛАДАХ ВИЩОЇ ОСВІТИ

**Анотація.** В освітньому процесі та в сучасній психолого-педагогічній науці й особливо в дидактиці фізики проблема формування активної особистості здобувачів вищої освіти відноситься до однієї з найбільш важливих та актуальних, що вимагає вирішення на сучасному етапі. Мета дослідження – визначення найефективніших засобів розвитку пізнавальної діяльності здобувачів вищої освіти на заняттях з фізики у педагогічних закладах вищої освіти. У статті проаналізовано проблеми освітнього процесу з курсу загальної фізики у вітчизняних педагогічних закладах вищої освіти. Проведений психолого-педагогічний аналіз виокремлених дефініцій та їх видів (діяльність, пізнавальна діяльність, навчальна діяльність, дослідницька діяльність, активність тощо). Охарактеризовано сутність поняття «самостійна пізнавальна діяльність». Закцентовано увагу на тому, що процес пізнання в галузі фізики, однаковою мірою як і процес навчання, здійснюється на основі інтегрованої діяльності, яка може бути представлена її теоретичною компонентою, а також експериментальною складовою, які однаково важливі і значущі. Розглянуто види діяльності у методиці навчання фізики: репродуктивний (що забезпечує розв’язання проблеми уже відомим способом, на основі попереднього досвіду), продуктивний (який проявляється у ході опанування нових знань саме в нових умовах) та творчий (що відрізняється від попередніх наявністю якісно нового елемента у вирішенні проблеми новим результатом). Представлено результати педагогічних досліджень та власне бачення вирішення проблеми активізації самостійної пізнавальної діяльності.
здобувачів вищої освіти у ЗВО: комплексне використання усіх наявних стимулів, технологій, методик, методів, прийомів, систем і засобів навчання, заохочення студентів до підвищення рівня діяльності, наприклад, від репродуктивного до творчого чи до чинників, що відображають: природну зацікавленість учнів (студентів) до пізнання природних явищ, професійний інтерес, підвищення рейтингу здобувачів вищої освіти у навчанні, майбутня кар’єра, прагнення до самовдосконалення та саморозвитку з урахуванням основних психолого-педагогічних та організаційно-методичних положень, які відбивають певний період чи етап розвитку як науки, так й освітньої галузі в цілому.

Ключові слова: самостійна пізнавальна діяльність, майбутні учителі фізики, педагогічні заклади вищої освіти, процес пізнання, індивідуалізація навчання, технології навчання, науково-дослідна робота, диференціація навчання.

**Problem statement.** The significant scientific, technical and economic development of our society determines the need for serious and significant changes in the higher education system, including in pedagogical institutions of higher education. When it comes to training a future highly qualified physics teacher, the problem stands out from others and is associated with changes and transformations taking place in the higher education system. At the same time, this problem actualizes the problem of providing high-quality comprehensive training of the younger generation in institutions of general secondary education, because graduates of institutions of general secondary education should be able to quickly adapt to new conditions that are observed and manifested in various spheres of our society. It is clear that this problem is closely related to the preparation of the young generation for the realization of the need to work effectively and learn throughout life and with the formation of each member of society readiness for constant self-improvement, self-development and self-realization, the formation of a person with an active life position, with critical, creative thinking, ready for decisive and effective actions for the sake of society.

**Analysis of recent research and publications.** The issue of developing independent work of higher education applicants has become the subject of scientific research by many Ukrainian researchers, in particular G. Gladkikh, A. Koval, A. Leplinska, L. Voievidko, I. Volokhova. Some aspects of activation and development of cognitive activity of future specialists of mathematical training were considered by D. Legeida, O. Ptashny, T. Yarkho, T. Yemelianova, art specialties – O. Loseva, T. Tkachenko, O. Shumska, foreign languages – O. Chernyshenko, O. Karasiova, T. Leshchenko, O. Shevchenko, economic specialties – T. Khomenko, H. Kovalchuk, L. Onuchak, H. Romanova. The issues of organizing independent work of applicants for higher education under the conditions of distance learning
were investigated by N. Honcharova, A. Horina, N. Nosenko, A. Riabova, A. Tsvid-Hrom.

The purpose of the article is a definition of the most effective means of developing the cognitive activity of applicants for higher education in physics classes in pedagogical institutions of higher education.

Summary of the main research material. Analyzing the problems of the educational process in the course of general physics in higher education institutions, which include classical and pedagogical universities, it is necessary to distinguish between the activities of a teacher who organizes, plans and implements everything related to the process of teaching the subject “Physics” and the organization of activities of applicants for higher education, for whom such activities act as educational.

Here, in our opinion, it is worth agreeing with the opinion expressed by S. Velychko [2] regarding the fact that the learning process, reflecting the activity of a teacher, is reduced not only to the transfer of a certain amount of already known educational information to educational applicants, the formation of specific skills and abilities, relevant ideas, etc., but also aimed at organizing and managing cognitive activities, which should be shown individually by each learner (or student) personally, and also aimed at solving a set of tasks related to the upbringing, formation and development of the personality of each educational applicant, as well as at the development of educational and search activities of each of them.

This is due to the fact that educational activity (or as interpreted in the research [2] “the process of teaching”) is considered “as a complex dynamic process of cognitive activity, which covers not only the mastery of what the teacher gives and is a generalized experience of humanity in the form of ready-made knowledge, advice and recommendations for their use in life, but also provides for each student to acquire their own experience in the knowledge of the surrounding world on the basis of independent knowledge operation and mastering the necessary actions and methods” [2, p. 14]. This applies to both the process of cognition and the process of teaching applicants for higher education, because in the course of general physics, students not only learn new physical concepts, laws, theories, ideas, reveal their essence, but, discovering them, learn to understand the essence of the object of study directly, generalize and systematize, gain experience both in the interpretation and application of the obtained physical knowledge in practice. Under these circumstances, applicants for higher education master a system of theoretical knowledge and practical skills, professional competencies and methods of educational, evaluative and practical as well as experimental activities, methods of self-mastering new knowledge about the surrounding world (nature) through the use of modern innovative technologies, including information and computer technologies, a system of educational physical experiments and facilities as well as equipment for reproducing compulsory educational experiments. In this aspect, it is
very important to take into account the influence and multicomponent learning environment in which the process of teaching physics in a particular higher education institution is organized, which is the sphere of professional activity for the future teacher.

Evaluating cognition as “a process of purposeful active reflection of the objective world in the minds of people, due to the socio-historical practice of mankind” [10, p. 491], we must consciously understand the concept of “cognitive activity of the student”, because the cognitive attitude of the subject (student) to the object (educational information in any form: facts, concepts, laws, regularities, physical theories, devices, methods and techniques of research, experiments, etc.) in the educational process arises precisely in the process of practical activity, which for the physical field of science and for natural sciences in general is allocated to experimental activity and is quite successfully functioning and implemented due to the comprehension and consideration of objective laws of reality. Therefore, acting as a secondary process in relation to practical activity, cognition (i.e., the student's cognitive activity) always actively affects practice.

At the same time, the theory of knowledge illustrates “the cognitive attitude of the subject to the object”, a person to the surrounding world, “the possibility of a person's knowledge of the world and himself, general prerequisites, means and patterns of the movement of knowledge, criteria for its truth” [10, p. 491]. In the meantime, the theory of knowledge reveals the initial conditions and general foundations of any knowledge that guarantee its objective truth, and is a generalization of the cognitive experience of mankind and “understanding knowledge as a dialectical process of approaching the subject to the object, moving from ignorance to knowledge, from incomplete, inaccurate knowledge, to knowledge more complete and accurate”, as well as introducing into the theory of knowledge “the principle of socio-historical practice as the basis of knowledge and the criterion of truth” [10, p. 493], illustrating the indissoluble unity of sensory reflection and abstract thinking and their qualitative specificity as a special form of cognition in their positive dynamics.

We emphasize that sensory reflection is based on the direct interaction of the subject and object, it has a specific figurative sensory form, and gives knowledge of phenomena that arise in our consciousness as a result of the action of external things. Abstract thinking is relatively independent and manifests itself in the fact that, arising on the basis of generalization of the properties of objects, it loses the specific form of sensuality and appears in the form of a concept. In the educational process, concepts can remain unchanged, and the surrounding world can change even with the existence of certain concepts, specific objects may be absent, or not yet fully realized (for example, the concept of “mass”, the unity of corpuscular-wave properties, as we have already emphasized, etc.). Quite significant in these circumstances in the theory of knowledge is such a state in which abstract thinking,
manifesting itself on the basis of sensory knowledge, “contributes to the improvement, formation, development of sensory knowledge”, and “generalizing historical experience, abstract thinking preserves for future generations the results of historical development of knowledge and creates the possibility of exchanging the results of knowledge between people”, “acts as an instrument of reverse human influence on the world, an instrument of transformation of the world” [10, p. 494].

So, taking into account the results that follow from the process of cognition, the cognitive activity of applicants for higher education, to which psychological and pedagogical aspects are added in the process of teaching the course of general physics, is constantly improved and developed, because studying the subject, the student first masters mechanical phenomena and processes, and then in the appropriate sequence thermal, electromagnetic, light and nuclear, which are characterized by significant complications. Under these conditions, new and significantly more effective methods of scientific research of natural phenomena and methods of pedagogical influence on the cognitive activity of a higher education applicant are being introduced, bringing it to self-realization, self-correction of the results obtained through the introduction of computer-oriented systems and learning tools created by new software and pedagogical tool, which significantly affect the independent cognitive activity of each student. Therefore, studying the general course of physics in the institutions of higher education for three years, the student at the final stage in the process of mastering the content and scientific and methodological apparatus in the research of physical phenomena and processes receives a fairly high level of cognitive activity, reaching the level of research, when the applicant operates with elements of novelty.

Consequently, the cognitive activity of a student in teaching physics is a rather deep and complex concept, which has been used for quite a long time in psychology, pedagogy and didactics of physics in order to assess and monitor the nature of the educational process in general in any educational institution. But when this concept is introduced to solve problems that are reduced to assessing its impact on the final results of the educational process of higher education applicants, a number of problems should be solved:

1. Some problems require the solution of relatively simple educational tasks related to the provision of independent work of applicants for higher education (material, didactic and scientific-methodological, instructional); such provision should reflect the current level of scientific achievements and modern scientific interpretation of the object (tool, means, subject) in independent study by the student to achieve and realize the desired result. These problems are usually solved by selecting the content of educational material and appropriate scientific and pedagogical methods of analysis, using appropriate computer oriented teaching methods, software and pedagogical tool, involving cloud technologies, etc.;
2. Other problems related to much more complex issues that at this stage of development of didactics of physics remain unresolved are at the stage of their solution (for example, the construction of a methodological training system “Quantum physics”, which solves a series of problems and tasks in connection with the organization of independent work of students in the process of mastering the theoretical aspects of a certain range of phenomena and processes, performing a number of experiments, experimental tasks, educational projects and specific research based on a synergistic approach and organization of cognitive activity of higher education applicants with the involvement of elements of artificial intelligence or their models through the creation of computer oriented teaching system or computer oriented teaching methods and the corresponding software and pedagogical tool, etc.);

3. Problems that are quite complex issues of both theoretical as well as practical and mathematical nature, which are not always consistent with experimental facts, or even those that require too complex modeling, for example, one that requires the construction of a new device like a collider, or the construction of a model for studying gravitational waves, etc., which at this stage in the didactics of physics is not yet possible to solve.

In connection with this and sharing the opinion of H. Atanov [1], cognitive activity should be understood as specially organized activity, which is aimed at assimilating the experience of previous generations, and the result of which is the formation of ways of action. In addition, we must clearly understand that the cognitive activity of applicants for higher education is closely related to the main stages of the cognition process, including: perception, awareness, comprehension, consolidation, generalization and application of acquired knowledge, skills and methods of activity in the future professional field, and, undoubtedly, research activities to which the applicant for higher education is involved while still studying at the University.

The main feature of research activity and difference from any other is the presence of elements of novelty and such elements that indicate the specific proposed author's practical methodology for performing research, the presence of “own scientific material” which is own analysis in the results obtained and their own conclusions about the problem that was studied, or their own new result. The optimal combination of educational and research activities of applicants for higher education is quite an important integrating point of the modern methodology of teaching physics, since it has got its name from their expedient integration, respectively, the educational and research activity of the student, which is especially distinguished in the process of studying natural sciences in higher education institutions, which is implemented on the basis of an experimental approach with the involvement of theory (theoretical mental activity) at the final stage in close combination with the results obtained on the basis of experimental activity, what is compulsory in teaching physics and in preparing a future teacher. Such educational and cognitive activity is carried out by applicants for higher education on a daily basis in the process of
teaching physics in a pedagogical higher education institution and develops due to certain human traits, such as curiosity, a spirit of inquiry, and the desire for research, on the one hand, and it is provided by the content of educational material and proven methods of teaching physics or other natural science disciplines on the other hand.

It should be noted that the completed system of combining various types of educational activities has not been created yet. Therefore, in practice, there is a variety of interpretations in methodological and pedagogical sources, in particular: educational and research, scientific and cognitive, search and research, research, scientific and research, experimental research, research and creative activities.

Here it is worth emphasizing that the process of knowledge in the field of physics (and other natural science branches), as well as the learning process, is carried out on the basis of integrated activities, which can be represented by its theoretical component, as well as an experimental component, which are equally important and significant. In the learning process, when the student still has little knowledge and insufficient personal experience, the experimental cognitive component prevails, and with the accumulation of knowledge, skills and abilities, experience and research competencies in general, theoretical mental activity becomes more important, although the results of experimental activity are shifted at the final stage in the direction where theoretical generalizations should be confirmed by experiments or practice.

Therefore, it is necessary to understand creative activity (creativity) to the same extent as reflecting the compulsory elements of novelty in the course of research activities, which relate to theoretical aspects in the study of physical phenomena, processes, and to the introduced methodology for performing educational research by a higher education applicant, including the introduced and created new author's methods, software and pedagogical tool, tools, systems and technologies for their implementation in teaching physics.

In practice, in the educational process, physics is considered in the teaching methodology (fig. 1):

Fig. 1. Types of activities in the methodology of teaching physics
1. Reproductive activity that provides a solution to a problem (task or exercise) in a well-known way, based on previous experience. This type of activity does not contain any elements of novelty.

2. Productive activity that manifests itself in the course of mastering new knowledge under new conditions. In this activity, it is the theoretical potential of the student and his intelligence that is more fully manifested.

3. Creative activity that differs from the previous ones by the presence of a qualitatively new element in solving the problem with a new result. This activity is implemented in the form of an option that no one has passed yet, it is a source of innovation.

Summing up the psychological and pedagogical analysis of the identified definitions and their types (activity, cognitive activity, educational activity, research activity, activity, etc.), we summarize: activity is one of the forms of human activity, which is not an innate personality trait, but one that is formed in the process of cognition. Therefore, it should be formed in the educational process and during the life of the individual, taking into account that the activity of the individual's actions and its activation are interrelated and interdependent. In addition, research activities should be activated, stimulated, and developed in the educational process in physics both in the institutions of general secondary education as well as in the institutions of higher education during the training of a student as a highly qualified specialist in the field of training.

In the didactics of physics, in the course of the development of cognitive activity of applicants for higher education, it is possible to practice such an organization of perception of educational material, when its full awareness by each student is carried out through a common interest and needs, as well as through the introduction of the necessary means and active actions to achieve conscious goals. In this case, some scientists pay attention to the fact that the process of learning development requires such activity of the teacher, which is aimed at encouraging the student to intensive purposeful implementation of cognitive activity, and the activation of educational and cognitive activity should be interpreted as the mobilization of intellectual, emotional-volitional and physical forces of the student, implemented by the teacher with the help of technical means, including ICT tools, and aimed at achieving specific goals in the learning process.

In pedagogical research under such circumstances, it is often and not without reason stated that the development of cognitive activity of applicants for higher education is also possible due to the use of a system of external actions on the part of the teacher, manual, methodological developments, educational environment, as well as other pedagogical influences, modern informational teaching technologies or ICT, which increase the level and quality of any student's activity in the appropriate state in which the subject of activity is located, which is characterized by an increase in activity.
In connection with these circumstances, we note that, in our opinion, the definition of the development and activation of cognitive activity of students in the educational process in the institutions of higher education is given more convincingly in the works of Z. Slepkon, which presents the activation of cognitive activity of the student as “a purposeful activity of the teacher aimed at developing and using such content, forms, methods, techniques and teaching tools that contribute to increasing cognitive interest, activity, creative independence of students in mastering knowledge, forming skills and abilities, applying them in practice” [9, p. 64], which is also fair for the formation of professional competencies of the future teacher, including his research competencies.

Therefore, in the process of studying the course of general physics in the pedagogical higher education institution, the teacher should organize and implement the educational process in such a way that in a short time to achieve the best positive result, which is a consequence of “the formation of the ability to think creatively, using the knowledge, skills and abilities acquired in the course of activity” [9, p. 76]. Developing this thesis, according to some researchers, it is also worth adding an increase in cognitive interest, activity in the classroom, independence in obtaining knowledge, which generally leads to the formation of competencies of a young physics teacher (fig. 2):

**Fig. 2. Factors influencing the development of cognitive activity of higher education applicants**

So, for the development of cognitive activity of the student, the teacher should organize the educational process based on the comprehensive use of all available
incentives, technologies, methodology, methods, techniques, systems and teaching tools, encourage students to increase the level of activity, for example, from reproductive to creative or to factors that reflect: the natural interest of learners (students) in the knowledge of natural phenomena; professional interest; increasing the rating of applicants for higher education in training; future career; striving for self-improvement and self-development.

Such activation of independent cognitive activity of the student should be carried out constantly and systematically, taking into account and in the relationship of the main psychological, pedagogical and organizational-methodological fundamental provisions that reflect a certain period or stage of development of both science and the educational sector of society as a whole, in particular:

– consistently take into account the growing role and significance of individual independent educational and cognitive activity of each student and use explanatory and illustrative methods, reproductive, heuristic and research methods, because independent work itself does not arise, but is formed and involves the acquisition of personal experience by each student in the knowledge of the surrounding world and, accordingly, in the process of teaching physics;

– it is important to introduce problem-based learning, as well as creative and individual tasks and tasks of various types (theoretical, practical, experimental, methodological), solving educational projects;

– a significant and quite important source of development of activity of applicants for higher education are the personal qualities of the teacher, his ability to intensify the mental work of students due to the skillful and rational use of time in the classroom, direct communication with the student and involving him in scientific work, which is performed by the teacher himself. The teacher's ability to create an atmosphere of benevolence, openness, empathy and partnership in relations with the student is also quite significant and important here. A special role in recent years here is given to computer and interactive learning, the introduction of computer oriented teaching systems and computer oriented teaching methods, software and electronic resources, distance learning, cloud technologies [11; 12; 13; 14] and STEM education, which are aimed at self-learning, developing students' skills of self-control and self-regulation of their own learning activities and self-correction of their results.

In solving the problem of activating the student's cognitive activity, it is useful to highlight this fact. Now there are already a number of scientific and methodological developments that give positive results, in particular, H. Kobel [4] suggests using modeling as a means of activating the cognitive activity of students in physics; A. Davydion [3] notes the expediency of attracting high school students and students to research work of students and participation in various competitions; significant are the methodological developments of H. Kostyshyna [5; 6], where the author emphasizes the importance of using multi-level problem tasks of professional
direction, as well as O. Slobodyanik's proposals on “compliance with the hierarchy of didactic goals, multi-vector possible options for using teaching tools, selection and creation of individual educational tasks that correspond to the motivational sphere, providing diagnostics and the possibility of adjusting academic achievements, ensuring subject interaction between the teacher and the student” [8, p. 7]. Under these conditions, individual training tasks are developed as individual educational theoretical tasks, individual educational experimental tasks, individual educational research tasks, individual educational methodological tasks, which have a professional direction and provide:

− development of the motivational sphere, value orientations, the need for activity;
− learning new knowledge and methods of action;
− unity of educational, developmental, and educative functions of the educational process;
− the focus of training on the formation of a system of actions and achieving cognitive changes in the individual;
− differentiation and individualization of training.

Significant, in our opinion, is the system of factors of activation of cognitive activity of students, which develops this activity in the study of physics, outlined in the research of V. Sergienko [7, p. 122] and quite fully reflects the motivational, content-operational and emotional-volitional components of cognitive activity of the student's personality, taking into account pedagogical requirements for their development in teaching physics and other natural science disciplines.

Thus, the activation of cognitive activity of applicants for higher education in teaching physics in pedagogical higher education institutions in the preparation of future teachers should be carried out taking into account psychological and pedagogical aspects, which are based on fundamental principles, on the integrity of educational, developmental and educational functions of teaching; a variety of forms, methods and means of teaching; through the development and introduction of effective incentives for the teacher and student, encouraging them to active learning activities; through the creation of an atmosphere of trust and partnership between the student and the teacher; aiming of applicants for higher education at the need for persistent independent development of knowledge; as well as the introduction of such forms and means of training that would simultaneously encourage students to active independent cognitive activity, to self-control, self-assessment and self-correction of their own academic achievements, to self-improvement.

**Conclusions.** The considered aspects give grounds to make a generalization that for the effective formation and further development of active cognitive activity of a student in physics, it is necessary to analyze modern teaching technologies more
deeply and introduce them much more widely in the educational process during the preparation of a future physics teacher in a pedagogical higher education institution, aiming them at the development of comprehensive experimental activities of applicants for higher education under the conditions of widespread introduction and implementation in the educational process of computer oriented teaching system and computer oriented teaching methods, methodological developments and software and pedagogical tool for effective problem solving, tasks and exercises as well as training projects of different types and complexity.

References:
Література:


