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## TRAINING OF FUTURE TEACHERS OF NATURAL SCIENCES IN PEDAGOGICAL UNIVERSITIES OF UKRAINE: REALITIES AND PROSPECTS

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**Abstract.** The article deals with one of the possible ways of advanced modernization of pedagogical education in Ukraine in order to create a base for the training of teachers of a new generation and to provide conditions for the formation and development of modern alternative models of professional and personal development of teachers. The idea that the integrity of the natural environment as an object of study causes the necessity of interconnection of the natural sciences that are involved to study it has been substantiated. At the level of higher education it is possible only if the principle of integration while constructing the content of the educational material will be used. It is considered as a dominant means of overcoming the contradiction between the integrity, the systemic nature of the wildlife and the fragmentary nature of its study.

The feasibility of introduction in Ukraine training of the teachers in specialty “Secondary education (Natural sciences)”, which should be interdisciplinary and multidisciplinary, has been highlighted. The possibilities of using an integrated approach in constructing the content of education of future teaches of natural sciences at all levels of its formation (general theoretical conception, academic discipline, educational material, pedagogical activity and personal gaining) and the specifics of its implementation at each level have been revealed. The possibilities to consolidate the efforts of the lecturers of academic disciplines of different cycles in order to form a forward-looking adaptation of future specialists to changing natural and social environments have been considered.

**Keywords:** training of teachers; natural sciences; integrated approach; content of education; pedagogical universities

Education is an indispensable indicator of the economic and spiritual growth of any nation, country. That is the reason for a shift in the emphasis of the world community towards educational issues. It activates the research in pedagogical science in Ukraine and promotes the emergence of new branches of knowledge at the intersection of existing ones or in combination with the essentially new ones.

VUCA-world model which was introduced for the first time in the USA for the military industry appeared in the scientific literature at the end of XX<sup>th</sup> century. Shortly after that, scientists came to the conclusion that this model can be applied in all spheres of human activity, including education. Its essence is bound up with the fact that today it is difficult to predict any processes in the world, the main characteristics of which are volatility (V), uncertainty (U), complexity (C), and ambiguity (A). The main task of today's education is not only to train a highly skilled specialist, but also to equip him/her with the skills and abilities of effective activity in the VUCA-world. Special attention is paid to the level of development of higher education institution graduates' ability to solve complex problems, their critical thinking, creativity, skills of personnel management, team interaction, decision making, etc. Thus, in the Concept of Pedagogical Education Development (2018) it is stated that its goal is to advance the modernization of pedagogical education in order to create a base for the training of the teachers of a new generation and to provide conditions for the formation and development of modern alternative models of professional and personal development of teachers who will facilitate the implementation of the Concept of the state policy realization in the field of reformation of General Secondary Education "New Ukrainian School" for the period up to 2029.

It is traditional for Ukraine to train teachers in one or two specialties, for example, a Biology teacher, a Physics teacher, a Chemistry teacher and the like. Therefore, there is a critical necessity to overcome such negative consequences of pedagogical education in a particular specialty as fragmentation of world perception, the complication of interprofessional communications, and the containment of the development of science because of the lack of new influx of knowledge and ideas from related fields. This leads to the necessity to rethink the content of education in favour of increasing the proportion of interdisciplinary and inter-sectoral integration of knowledge, which is only possible on the basis of the transition from knowledge of facts to universal competencies in the form of holistic combinations of approaches, methods, principles, ideas, understanding and attitude. Therefore, these days the Ministry of Education and Science of Ukraine prefers to train teachers in two or more academic subjects simultaneously (for example, a teacher of biology, human health and chemistry). One of the possible ways of solving the above-mentioned problem is introduction in Ukraine beginning from 2018-2019 academic year training of the teachers in specialty "Secondary education (Natural sciences)", which is interdisciplinary and multidisciplinary, provides the integration of educational and professional programs "Secondary education (Physics)", "Secondary education (Chemistry)", "Secondary education (Biology)". Specialists who will be trained according to this program will receive a qualification: a teacher of natural sciences, physics, chemistry, biology, which greatly enhances their employment opportunities. Realization of this task is possible only by using an integrated approach to the designing of educational activities.

One more direction in realization of the principle of the scientific areas of education integration is the so called STEM-education. Its name consists of the initial letters of English words: “Science” (Natural Sciences), “Technology”, “Engineering”, “Mathematics”. STEM-education means a transdisciplinary approach to the study of phenomena and processes of the surrounding world. This direction is also gaining popularity in Ukraine. That is why the introduction of the principle of integration into the Ukrainian theory and practice of training is currently being actualized.

### **The analysis of the recent research and publications**

The scientists S. Honcharenko, V. Ilchenko, A. Stepaniuk and others substantiated that the integrity of the natural environment as an object of study causes the necessity of interconnection of the natural sciences that are involved in its studying. The biosphere with the variety of life manifestations in it is studied as a complex of interrelated sciences, each of which has its own subject of research. Their combination in a single integrated course is one of the most important tasks of modern pedagogical science. It is possible only if the principle of integration while constructing the content of the educational material will be used. We consider the embodiment of this principle as a means of overcoming the contradiction between the integrity, the systemic nature of the wildlife and the fragmentary nature of its study.

The analysis of literary sources (Kedrov, 1981; Stepaniuk, 2012) testified that there are two concepts of integration. The first one is traditional, which connects the integration of knowledge mainly with the logic of the internal development of science, with the reflection of the interconnections and the systemic nature of the objects of cognition, the material unity of the world. Its essence is in the necessity to eliminate artificially created barriers in scientific knowledge and bring science into conformity with the objective nature of the connections of nature and society, the unity of the material world. Representatives of the second concept explain the integration of science exclusively by activity factors, proving that the basis of integration, its source is not the objective reality itself and its properties, but the social activity, the needs that it generates. The material unity of the world influences the process of integration indirectly through practice.

Nowadays philosophers try to synthesize the named concepts, believing that it will facilitate a new creative search. We completely share the views of the researchers who believe that there are two bases of integration. Speaking about natural sciences education it means that there are two bases for integration of the content of knowledge about nature: the material unity of the world and the needs that the socio-historical activity of mankind generates.

Taking into account conditions of the present time, the problem of integration of the content of education is urgent for modern didactics which primarily considers integration according to the following levels: general methodological (actualization of the role of philosophy in the system of scientific knowledge), general scientific

(the use of general scientific forms and means of cognition in the educational process), partial scientific (orientation from general to partial, the transfer of structural elements of scientific knowledge from one cycle of disciplines / subjects to another) (Bak & Stepaniuk, 2015; Stepaniuk, 2012).

The analysis of foreign teacher training syllabuses and curricula proved that integrated courses are dominant in the United States, the United Kingdom, Canada, and other developed countries. For example, the subjects of natural sciences cycle are combined into a cycle “Science” (geography, biology, physics, chemistry) (Olendr & Stepaniuk, 2018). However, the technologies of training future teachers for integrated teaching of the subjects of natural sciences cycle have not been properly elaborated yet.

The **goal** of the article is to highlight the possibilities of using an integrated approach in constructing the content of education at all levels of its formation in the training of future teachers of natural sciences.

### **Theoretical Study Results**

As it is generally known, the content of education is projected on five levels: general theoretical conception, academic discipline, educational material, pedagogical activity and personal gaining. Let us consider how to implement an integrated approach at each of these levels, as the preparing of future specialists – teachers of the natural sciences – has its own specific structure, content, forms and methods of training.

*At the first level* (general theoretical conception), in the system of higher education goals are defined in the context of relevant industry standards, educational and professional training programs. It is stated in the Concept of Pedagogical Education Development that the key task of higher pedagogical education is to train teachers-researches who are able to solve complex problems in the field of pedagogical and / or research and innovation activities, which involves a deep rethinking of existing and creating new integrated knowledge and / or professional practice. Teachers-researches have to be able to carry out analytical comprehension of the state and prospects of development of the sphere of education, to create and implement a new content of education and the newest teaching methods (technologies), to combine their own pedagogical activity at a high professional level with the dissemination of new knowledge and best practices in the pedagogical community, continuation of the national school traditions. In this context we consider the training of teachers in the field of study “Natural sciences” as a pedagogical process aimed at learning the system of knowledge in the field of natural sciences and pedagogy with a view to their further use in professional activities and the formation of their own integral natural-scientific picture of the world and world outlook.

*At the second level* (academic discipline), the content of education is determined by designing curricula and syllabuses. Nowadays there is no requirement to follow

a unified curriculum for training specialists in Ukraine. Every higher education institution draws up and approves itself the curriculum for the training of future teachers in accordance with industry standards. Lecturers of higher education institutions elaborate their own syllabuses on its basis, which are approved only at the level of departments as structural subdivisions of universities. This approach has both positive and negative experience. We refer a possibility of providing variable models of students' own individual learning paths to the positive experience. Various complications which students come across during their study mobility (which allows students to obtain certain credits in academic disciplines at different institutions of higher education in Ukraine and abroad) can be considered as negative experience.

The conducted analysis of the content of the teacher training curricula, the school syllabuses of the relevant subjects and the comparison of the gained results with the requirements for the level of the professional competence formation of future teachers, let us conclude that the curriculum for training specialists in the specialty 014 "Secondary education (Natural sciences)" for the second (Master) cycle of higher education should include such integrated academic disciplines as: "Achievements and Problems of Natural Sciences", "Physical and Chemical Processes in the Environment", "Modelling and Forecasting of Natural Processes", "Tendency of Integration in Modern Natural Science", "STEM-education in the Field of Natural Sciences", "Physico-chemical Methods of Research of Substances and Materials" (anticipate interdisciplinary integration) and "Structurally-functional Organization and Evolution of Living Systems", "Didactics of Natural Sciences" and others (implement interdisciplinary integration).

*At the third level* (educational material), integration is realized through the formation of an **integral** (the ability to solve complex problems and the problems of natural sciences and their teaching, which involves research and implementation of innovations, their critical analysis, and is characterized by uncertainty of conditions and requirements), **general** and **professional** competencies.

*At the fourth level* (pedagogical activity), the monitoring of the educational process has been conducted, which showed that the majority of the interviewed lecturers (92.6% of the respondents), who provide teaching of natural sciences in pedagogical higher education institutions of Ukraine, implement an integrated approach in constructing the content of education within their competence. But at the same time they experience considerable difficulties in the development of integrated tasks and the selection of educational material for the holistic consideration of phenomena and processes of nature. Consequently, there exists a contradiction between the necessity to implement integrated training of specialists and its practical application.

The conducted analysis of literary sources, the results of the diagnostic experiment, and our own long-term experience of pedagogical activity suggest that in

order to improve the quality of the professional training of future teachers of natural sciences, it is expedient to implement the contextual teaching technology, which we interpret as a means of integrating the content of higher education and school education. Its use as an innovative technology (Verbitskiy, 2010) contributes to the organization of students' activities in accordance with the laws of transition from educational texts and sign systems, as carriers of past experience, to professional activities with competence orientation. It provides the transition, transformation of the cognitive content into the acquired knowledge, into practical and professional competencies, promotes the connection of academic knowledge with the context of the real life situation, and attracts students to meaningful for them activity. Thus, the accents in interpreting students as subjects of educational-cognitive activity are shifted to their consideration as subjects of pedagogical activity. The use of the contextual teaching technology enables to consolidate the efforts of the lecturers of academic disciplines of different cycles in order to form a forward-looking adaptation of future specialists to changing natural and social environments, as well as obtaining an emergent result of joint pedagogical activity.

The results of the conducted questioning of 54 lecturers of the academic disciplines from the cycles of natural sciences (fundamental), professional and practical training of the National Pedagogical Dragomanov University (Kyiv) and Ternopil Volodymyr Hnatiuk National Pedagogical University (Ternopil), analysis of the attended classes showed that the technology of contextual teaching is not sufficiently used during the educational process at higher education institutions. Professional orientation in the syllabuses of academic disciplines was mentioned only by 5.5% of the respondents to be the study purpose.

No tasks of professional orientation were applied at the attended lectures. The results of the conducted questioning proved the existence of the following dominant thought at pedagogical higher education institutions – the aim of studying academic disciplines is to study the fundamentals of science. But they also constitute the basis for the formation of only a cognitive component of the professional competence of the future teacher of natural sciences. 92.6% (50 lecturers) are not acquainted with the concept of “a model of the academic subject, which is included in the curriculum with the dominant aim of gaining knowledge” (Stepaniuk, 2012). Exceptions are made by the teachers, who provide teaching of methodology of school natural sciences courses teaching. Out of them 3.7% (2 lecturers) use this concept in practice and the same number of respondents is acquainted with it, but consider it to be unnecessary in the professional training of teachers which “complicates teaching process too much”. However, the conducted analysis of literary sources (Stepaniuk, 2012) suggests that the content of a student's educational activities should be formed not only based on the logic of science, but also taking into account a model of the academic subject and the logic of future professional activities.



We suggest while studying the academic disciplines for professional and practical training to hold lectures making pauses, during which the students will compare the content of the educational material that is taught at the lecture with that offered in school textbooks. At the laboratory classes maximum attention is paid to performing experiments and practical studies which are included in the school syllabuses of “Physics”, “Chemistry”, “Biology” and “Natural Sciences”. At the same time special attention is drawn to the reflexive dialogue, which contains considerable potential for the establishing of “inter-subject” relations between the lecturer and the students, between the students themselves and also between the students undergoing practical training and pupils at schools. The implementation of such an approach involves the use of a system of educational and cognitive tasks, the systematic factor of which is the idea of integrating the content of the natural-scientific training of future teachers and the content of school subjects relating to nature as the object of study. The main aim is the formation of holistic perception of objects and processes of the natural environment.

*At the fifth level* (level of personal gaining), on the basis of our comparative study of the monitoring of the natural science education quality in the US and Ukrainian universities (Olendr & Stepaniuk, 2018) the final results (competencies) that the future teacher of natural sciences must acquire at the level of the first higher education qualification (bachelor) and the second (master) are determined.

The forming experiment was conducted in order to verify the reliability of our assumption concerning feasibility of implementing an integrated approach to constructing the content of education at all five levels of its formation in order to improve the quality of the training of future teachers of natural sciences. The criterion of the effectiveness of the experimental methodology is the quality of formation of the future teachers’ readiness to implement an integrated approach in teaching pupils the subjects of natural sciences cycle. This readiness is determined by us as an integral quality of a personality, characterized by a steady orientation to actualize an integrated approach in teaching pupils, has a complicated structure and encompasses motivational, content, operational and reflexive components. After the implementation of the experimental methodology, which ensured realization of the integrated approach at the level of pedagogical activity, we carried out a survey and based on its results the coefficient of academic performance was calculated by both main characteristics defining the formation of the corresponding structural components of the analysed readiness, and by its integral index.

### **Conclusions**

The integrity of the object of study, namely nature, prompts the use of the principle of integration as dominant in the process of formation of the content of education of the future teachers of natural sciences. Its implementation in the educational process at higher education institutions has allowed increasing of the quality of

educational services considerably. That substantiates feasibility of introduction in Ukraine training of the teachers in the specialty “Secondary education (Natural sciences)”, which should be interdisciplinary and multidisciplinary. However, this process requires a holistic vision of natural sciences content, singling out common fundamental ideas, abilities to combine isolated scientific knowledge into one. The prospects for further study consist in the research of these factors.

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