

The Modern Knowledge of Microbiology is an Important Aspect of the Research Competence of the Future Bachelor in Natural Sciences

Gramatyk N^{1*}, Bila O² and Ivanova D³

¹Department of General Pedagogy, Pre-school, Primary and Special Education, Izmail State Humanitarian University, Ukraine

²Department of Pedagogy, Preschool, Elementary and Special Education, Izmail State University of Humanities, Ukraine

³Izmail State University of Humanities, Ukraine

Abstract

European vectors of science education are aimed at formation not only just a teacher who is able to easily adapt to rapidly changing conditions, but a professional researcher capable of creative and transformative activities of biomedical practice.

Modern knowledge of microbiology in the system of professional training of future bachelors of natural sciences is an effective resource for the formation and development of students' research competence. On their assimilation by a future teacher of natural sciences depends the degree of its readiness for practical activity, that based primarily on the availability of integrative and biomedical professionally directed knowledge, including in microbiology.

Proceeding from this, particular value in the professional and pedagogical training of future bachelors of natural sciences are the microbiological knowledge as a modern branch of biology, as well as the basis for the formation of subject competence in the process of teaching the microorganism knowledge system in the integrated school course «Natural Sciences».

Keywords: Bachelor of Natural Sciences; Research Competence; Disciplines of the Biomedical Cycle

***Correspondence to:** Nadiia Gramatyk, Department of General Pedagogy, Pre-school, Primary and Special Education, Izmail State Humanitarian University, Ukraine; E-mail: Gramatknadea@gmail.com

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Introduction

The integration of the educational systems of civilized countries into the European educational society actualizes the process of modernizing the educational content of the younger generation and Ukraine at all its levels. One of the ways to update the content of education in the plane of taking into account the modern needs of the Ukrainian society is to orientate the educational programs towards the formation of students' key competencies and create mechanisms for their acquisition by students. The analysis of scientific publications and educational practices suggests that it is the integration in the practical plane of the active implementation of the competency-based approach that focuses on the effectiveness of the educational strategy as well as the use of its value potential that characterize the innovations of successful education systems. And now, society's demands for a modern comprehensive school and its competitiveness in the light of the imperative of a single world educational space are becoming increasingly stronger. The aforementioned actualizes the corresponding transformations of the content and approaches to the professional training of the future teacher, teacher of the new formation. In this regard, we emphasize that it is research competence as the most important component

of the professionalism of the future teacher of Natural Sciences that acquires special urgency. Moreover, the practice-oriented vector of development of higher pedagogical education has especially increased attention to this issue. First of all, this is due to the defining role of the teacher's personality in the process of implementing new strategies for school science education.

The experimental activity of students, as one of the key activity of New Ukrainian schools, provides a reorientation of the teacher's personal and professional mission in the transformation of the "soft skills" of the educational space from the passive acquisition of knowledge by the younger generation to the active development of practical experience [1]. The main condition for the effectiveness of such an activity is the professionalism of the teacher of Natural Sciences, which is manifested in the plane of analytical orientation in relation to objective activity. All this caused the priority of higher school tasks related to the development of future bachelors of Natural Sciences of research competence in the process of their professional training.

It should be noted that the formation of research competence is a complex cognitive and creative process. The presence and formation of



research knowledge and skills is one of the brightest characteristics of the level of professional maturity of the future teacher. That is why the priority of the system of higher education today is rightfully forming not just a professional executor, but a professional researcher who is able to adapt to the dynamic conditions of society, find constructive solutions to emerging problems by relying on an analytical and critical style of thinking.

The analysis of scientific publications on the issue raised suggests that professional competence and the problem of its development are in the focus of attention of many scientists. In particular, some aspects of the formation of the research competence of the future Natural Science teacher are considered in the works of Ukrainian and foreign scientists [2-6]. An analytical review of scientific and pedagogical research devoted to the problem of training future teachers of Natural Science, indicates that it is quite relevant for both domestic and foreign systems of higher education. First of all, this is connected with the European vectors of studying the school course in Natural Sciences, focused on the knowledge of the 21st century and their practical application in different areas of life. Thus, a detailed analysis of the content lines of the "Natural Sciences" educational sphere of the new educational standard of basic secondary education in Ukraine allows us to state that modern knowledge of microbiology is widely represented in the educational topics of the Biology program. The matter concerns, in particular, the logic of studying thematic modules related to knowledge of viruses, bacteria, algae, fungi, protozoa, and the diversity of habitats, environmental ecology, modern agricultural technologies, food industry, medicine, genetic engineering and biotechnology. According to domestic educational practice, the integration of modern knowledge of Microbiology in the process of studying a school biology course allows us to expand not only the theoretical training of students, but also fill it with empirical content, which corresponds, in particular, to the strategies of the New Ukrainian School. Consequently, there is a need for more advanced training for future bachelors of science, which is based primarily on practice-oriented knowledge, in the context of which the substantial component of microbiology is updated.

We share the existing point of view that the training of future teachers as a complex multi-faceted process should be aimed at the personal-professional formation of the creative personality of a student who is ready for innovative activity [7]. Proceeding from this, a modern teacher of Natural Sciences should possess a wide range of Natural Science knowledge, be fluent in current biomedical issues, and be able to creatively apply them in professional and pedagogical activities. Additionally, from the point of view of the subject preparation of future bachelors of the Natural Sciences, it can be argued that at the present stage, the Natural Science teacher ensures the implementation of the main tasks of not only the school subject of Biology, but also science education in general. Therefore, the key issues of practical Microbiology, as a modern branch of Biology, should be included in the basic training of bachelors of Natural Sciences.

Meanwhile, it should be noted that there are contradictions between modern approaches to the study of Natural Science and the imperfect orientation of the process of preparing a future teacher for the development of their research potential. Thus, a systematic analysis of the educational and methodological content of the discipline "Microbiology and Virology" showed insufficient use of a research resource, which is significantly discordant with modern requirements for the training of future Science teachers.

The purpose of the article is to justify the fundamental importance

of biomedical knowledge in the acquisition of research competence by future bachelors of Natural Sciences; to detail some experience in the formation of students' research competence based on the resources of the professionally directed discipline "Microbiology and Virology". To achieve this goal, it became necessary to solve a two-pronged problem:

- To analyze the research positions of domestic and foreign scientists on the problem of research activity in the higher education system, as a result of which, to clarify the content of the research competence of the Natural Sciences teacher;
- To carry out self-reflection of the practice of teaching the practice-oriented discipline "Microbiology and Virology", using the regional imperative in teaching the integrated school course "Natural Sciences".

Materials and Methods

To solve the set tasks, mainly theoretical (analysis of the scientific literature, with the aim of determining and theoretical justification of the problem of research competence formation) and empirical methods - (pedagogical observation, testing of future bachelors of Natural Sciences in order to determine the readiness of research activities in the practice of the school educational process as well as statistical methods of processing the received data) were used.

Note that in the current academic year, the introduction of the experimental integrated course "Natural Sciences" in grades 10-11 of institutions of General secondary national education was prolonged. Teachers of physics, biology, chemistry, and geography can teach this course. It is assumed that the entire practical course is taught by one teacher. Our observations revealed that in the practice of the Ukrainian education system the situation is dominated when the subject "Natural sciences" is preferably given to a Biology teacher. This is confirmed by a special study. The aforementioned reinforces the need to review the essence of professional training for the future teacher of the natural history cycle as a teacher of a new formation. At the same time, we share the opinion of those researchers who believe that the future biologist over the years of study at the university must definitely gain experience in research activities, learn to navigate and act in non-standard conditions, recognize the importance of continuous self-improvement and creative self-realization and become competent in his profession. Thus, the need arises to problematize the content of the professional training of future bachelors in the Natural Sciences, and to use the problem-based approach to the organization of the study of practice-oriented educational disciplines.

We add that in the context of the European parameters of quality education, "competence" is mainly interpreted as an integrated personal characteristic, an effective unit formed through the experience of training, knowledge, ability, relationships and behavioral reactions [7]. We agree with the understanding of research competence as a combination of scientific knowledge, intellectual, practical and organizational skills aimed at performing professionally directed actions, while taking into account some clarifications [8-10].

In connection with the aforementioned, the position of Peklaj C (2015) [11] impresses that in the 21st century it is the research competence of the future teacher that is the factor of his professional success. Despite the diversity of views regarding the essence of the research competence of the future teacher, Mussarat J (2019) [12] claims that the quality of education is achieved by three key conditions, namely: training a new generation of teachers-researchers, creating an educational space that stimulates creative thinking and building



competencies in life-supporting industries. Therefore, proceeding from the specificity of the tasks of the modern teacher of Natural Sciences, as well as summarizing the scientific views on the essence of the concept of “research competence”, we conclude that this personal and professional quality can manifest itself only in organic unity with the motives and values of a person interested in a particular type of activity. In addition, the very nature of the future teacher’s research competence has the potential of professional self-realization. Although, research competence is a product of learning, it is not a direct result, but rather a consequence of the student’s self-development, his personal growth as a future specialist.

As part of the study of the professionally directed course “Microbiology and Virology”, modern knowledge of the characteristics of the microworld is fundamentally important for students. In turn, the students’ conscious understanding of scientific facts, laws and relationships between phenomena and objects of reality is the primary basis for the formation of relevant practical skills. It is in this plane, in our opinion, that the process of assimilation by future bachelors of the Natural Sciences of microbiology as a modern branch of Biology, including the basic elements of bacteriology, virology, immunology and protozoology, as the most demanded in future pedagogical activity, should be carried out.

Note that according to the goals of the Microbiology and Virology curriculum, students should be able to analyze, describe the main groups of microorganisms, their morphology, habitats, their role in nature and human practice, be prepared to manufacture drugs, and explain the results. Such subject modules as the morphology and physiology of microorganisms, infection, immunity, sanitary, special and environmental microbiology, as well as general virology are directly subject to study. Thus, the indicated content of the course acts as the core of the biomedical readiness of future bachelors of Science, because they integrate the knowledge of various natural sciences (biochemistry, molecular biology, genetics, physiology, etc.) among which some are basic for studying microbiology, while others are the basis of their practical application. This understanding underlies the training of future bachelors of Natural Sciences at Izmail State University for Humanities in the specialties 014 Secondary Education (Natural Sciences) and Secondary Education (Biology and Human Health) in the process of studying the discipline “Microbiology and Virology”.

Describing the readiness of the future bachelor of Natural Sciences for professional pedagogical activity, it is necessary to note its multi-component nature. In this plane, we understand the readiness of the subject of the implementation of modern Natural Science knowledge as a complex, integrative and dynamic pedagogical phenomenon.

In order to identify the willingness of future teachers for research activities in the process of teaching school subjects “Biology” and “Natural Sciences”, a survey of students was conducted. The survey involved 55 bachelors of these specialties. The results of the survey revealed that most students had difficulty organizing independent research activities (20 people-36%); the part does not consider research activity an obligatory component of future professional activity, but designate it as a teacher’s personal preference (8 people-15%); do not correlate research activity as a way of deepening and expanding Natural Science knowledge (3 people-5%); they do not see the possibility of using the regional component as the basis for the experimental activities of students (5 people-9%); note a low interest in research activities (19 people-35%).

The obtained results actualize the need to search, develop

and theoretically substantiate effective ways to form the research competence of future bachelors in the Natural Sciences, in the process of studying the varied academic discipline “Microbiology and Virology” and determine a strategy in this regard.

So, the substantial components of the school Biology course involve the study of the medical, economic, social and moral-ethical aspects of the emergence and spread of various diseases, including the viral infections characteristic of the children’s community (influenza, rubella, measles, herpes, etc.), as well as therapeutic and preventive measures, which are based on the integration of biomedical educational disciplines. In addition, in a school Biology course, microbiological knowledge is vital, since it affects personal hygiene, food processing and preservation, the prevention and treatment of infectious diseases, that is, they serve as the basis for the formation of a health-saving competency [13].

Based on the generalized tasks of our scientific search, the priority in the process of studying the discipline “Microbiology and Virology” was to intensify the research activities of future bachelors of Science by integrating the regional imperative into the content of the educational material of a professionally-oriented course. The chosen strategy is also due to the specifics of the professional and pedagogical activities of the future Science teacher, which consists in implementing the substantive line of the new biology curriculum “Environmental Safety and Sustainable Development”, aimed at the formation of eco-ethical principles among young people. These positions in the professional activities of teachers are also defined in the Concept “Education for Sustainable Development” and the Concept of Environmental Education in Ukraine.

It is worthwhile to say that the practical part of the discipline “Microbiology and Virology” for bachelors of specialty 014 Secondary education is aimed at the ability to independently produce and fix microorganism preparations, identify them, study the microflora of various media (air, water and soil), as well as cultivate microorganisms on various nutrient media.

To achieve the predicted results, we have supplemented and expanded the substantive modules of the discipline by integrating the environmental component, revealing the current problems of the region and fundamental natural science knowledge. Our hypothesis was that this strategy of professional training of future bachelors of Natural Sciences will effectively influence the increase of their motivation for research activities, more efficiently form a scientific worldview, a holistic vision of a future profession, as well as positively develop students’ environmental awareness. Furthermore, the organized process of studying the discipline “Microbiology and Virology” was regarded by us as a kind of segment of continuous environmental education and upbringing of student youth.

We completely agree with the position of researchers [10] regarding the importance of the formation of students’ practical skills. Therefore, laboratory classes of students were selected as the core of the integrative approach, as well as extracurricular work, which involved the study of popular science sources, search and research work on a given topic, participation in meetings of problem groups, as well as the implementation of tasks of an applied nature. Besides, experience has shown that it is advisable to focus on cooperation with the public organization SOES (Self-organizing educational space) on ecology and environmental protection in the region, which on the basis of our university not only created a platform for developing students’ skills, but also initiate their participation in international environmental projects.



The use of the regional component in the content of the module provided for focusing students' attention on the environmental condition, in particular, the water ecosystems of the Ukrainian Danube region, identifying the cause and solutions using microbiological technologies.

Note that focusing student's attention on the region's water resources is not unreasonable. The Ukrainian Danube region is located in the arid region, which has a huge amount of water resources (Danube, Danube Lakes, groundwater), which is unique to the steppe zone. The uniqueness of the region lies in the fact that the Ukrainian Danube region is a part of the Pan-European Ecological Network, the formation of which was proclaimed by the European Union in 1995 (Spain, Seville), as well as a part of the national ecological network of Ukraine approved in 2000 [14]. Unfortunately, in the last decade, the exacerbation of environmental problems associated with microbiological indicators of water resources has been an important factor for the Danube region. Studying the ecosystems of the region, students also get acquainted with the traditions of the economic activities of ethnic groups, stereotypes in behavior in relation to the natural environment of local residents, which forms the willingness of future teachers to implement such a didactic principle as local history in the teaching of a school Biology course.

In this regard, the goal of the laboratory lesson on the topic: "Ecology and Microorganisms" was bioindication of strategically important water arteries for the region. So, the extracurricular part of the students' research activities involved the selection of water samples from the life-supporting Danube region reservoirs (Danube River, Lake Yalpus) to study its microbiological indicators [15-17].

Students' direct research activities involved such practical actions as: filtering selected water samples, placing them in nutrient media, followed by reseeded to more enriched ones, monitoring the growth of colonies of microbiological cultures, identifying and determining microorganisms in the obtained samples, recording and analyzing the results.

So, among the cultivated crops, lactose-positive entobacteria were revealed, the content of which significantly exceeded the established sanitary standards. This indicates that water is epidemiologically dangerous, since the detected microorganisms are an indicator of bacterial and viral pollution of water bodies. For a deeper thematic study of the main sections of Microbiology and Virology, students selected 20 samples of water from the Danube River and sent to the city bacteriological laboratory for detailed research. As a result, the NAG vibrio (on-O1 *Vibrio cholerae*) was found in one of them. With the help of scientific literature, future educators came to the conclusion that this microorganism is not toxic, but can cause a number of infectious diseases, including cholera-like diarrhea and other gastroenterocolitises [18,19].

At the final stage of the experimental teaching of the basic course "Microbiology and Virology" - the backbone in the preparation of the new generation of bachelors of Natural Sciences - a test was conducted.

An analysis of the data obtained allows us to conclude that 67% of students revealed their readiness for environmental education of schoolchildren in the process of teaching a school biology course based on local history materials. The results of the control testing of bachelors of Natural Sciences showed that the number of future teachers who are ready to organize research activities of students in the practice of teaching Biology is 47 people (85%), this fact confirms

our hypothesis. It should be noted that the systematic self-organizing activities of bachelors had an impact on the indicators of educational achievement of students, which helped to increase their academic rating. An indicator of the success of this methodology for teaching professionally oriented discipline was the fact that 39 students (71%) show strong beliefs in the need to integrate biomedical knowledge, the use of intersubject communications, as well as the importance of experimental work in the framework of the integrated course "Natural Sciences".

Conclusions and Prospects for Further Research

Self-reflection of pedagogical activity, as well as the results of a comparative analysis of students' professional training, allow us to solve the problem of forming the research competence of future bachelors of Natural Sciences at a qualitatively new level. The matter concerns the importance of integration, in particular practice-oriented knowledge in Microbiology, to deepen understanding and assessment by future teachers of the modern environmental and socio-ethical problems of modern society, to determine approaches to their solution using modern biotechnologies. Beyond that point, the organization of the contextual formation of a system of knowledge about microorganisms significantly expands students' ideas about the possibilities of modern biomedical science in the context of studying the subject "Microbiology and Virology".

Further research requires justification of the technology of formation of biomedical culture among students as the basis for the formation of new generation of teachers.

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