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Original Article

Formation of natural scientific competence in future teachers of physical education

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Abstract:
The article presents the research results conducted to verify the effectiveness of the methodology of formation of competence in natural sciences with future teachers of physical culture. In order to determine the effectiveness of the methodology of the formation of competence in natural sciences, the pedagogical experiment was carried out in higher education institutions of Ukraine which are training future teachers of physical culture. The experiment involved 30 teachers of natural sciences and 568 students. Controlling and experimental student groups were selected for the experiment. In experimental groups, the methodology of natural and scientific training of future teachers of physical culture was implemented, the features of which are the use of a modular object-oriented dynamic learning environment. This learning environment contains electronic teaching materials for the formation and assessment of the level of formation of competence in natural sciences; it also allows to use forms and methods of training that create the conditions for the manifestation of autonomy, initiative and creativity of students. The processing of experimental data was carried out using methods of mathematical statistics. After the generalization of research, it has been established that in the groups where the experimental method was implemented, the percentage of students with high level of formation of natural sciences competence increased, and with low level – decreased. Students of experimental groups are more motivated to study natural sciences, have a higher level of formation of knowledge and can apply them to solve professional problems. They have personal qualities that make it possible to succeed in professional activity and public life in general. This testifies to the effectiveness of the methodology of the formation of competence in natural sciences with future teachers of physical culture.
Key Words: natural scientific competence, natural science training, modular object-oriented dynamic learning environment.

Introduction

Today, when the education system takes a competent approach, the main result of the training of specialists in higher education institutions is professional competence. The necessity of designing the results of the educational program as a list of professional and general competencies actualizes the problem of rethinking the role of science and education, which, as part of vocational education, ensures the formation of the qualities of a future specialist. These qualities are determined by the fundamental component of education, affect the readiness of a student for acquisition of professional training disciplines, the level of a student's mobility, competitiveness and demand in the labor market.

Natural science is fundamentally important for a teacher of physical culture, since his or her future professional activities are directly related to the use of knowledge of various sections of biology. The teacher of physical culture must know biochemical composition and anatomical structure of a human body; understand physiological processes that ensure vital activities of the organism, and the processes of metabolism at their basis; understand how physical exercises affect a human body; be able to determine optimal physical activity; use methods of determining the structure and functional characteristics of a human body. At the same time, the analysis of the present state of future physical culture teachers in natural science shows that its possibilities are only partially realized. Taking into account the above mentioned, the formation of natural scientific competence with future physical culture teachers is an actual task of pedagogical theory and practice.

Material & methods

The purpose of the study was to develop and experimentally test the methodology for the formation of natural scientific competence of future physical culture teachers.
Formation of natural scientific competence involved four stages of experimental research work.

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At the first stage, the existing state of natural science training of future physical culture teachers was studied. The following research methods were used: analysis, synthesis and generalization to compare different approaches of scientists to the problem of science and education; questioning and testing of students, observing the educational process in order to find out the current state of scientific training of future teachers of physical culture in higher education institutions.

The second stage included the development of a methodology for the formation of natural scientific competence for future physical culture teachers by using the modular object-oriented dynamic learning environment (Moodle). This is a program complex designed to create electronic training courses in the Internet to organize interaction between teachers and students. With the aim of natural scientific competence formation of future physical culture teachers, there were developed electronic courses on the following natural sciences disciplines: "Biology", "Human anatomy", "Human physiology", and "Biochemistry". Each course contains educational and methodological materials of the discipline (informational teaching materials, laboratory works, tasks for independent work, tests for various types of control) that provide the formation of knowledge, skills and practical competences, development of personal qualities of a future specialist. During the selection of electronic courses' content of natural sciences disciplines, the peculiarities of professional training of future teachers of physical culture were taken into account.

In the third stage, a pedagogical experiment was conducted to determine the effectiveness of the developed methodology for the formation of scientific competence of future physical culture teachers. It has the statement and formation stages. The experiment involved 30 teachers of natural sciences and 568 students. At the statement stage, the controlling and experimental groups (CG and EG) of students were selected and the initial level of their natural scientific competence was determined. To confirm the absence of statistically significant differences between the levels of scientific competence in the students of CG and EG and to ensure the reliability of the results in experimental work, the Fisher φ*-criterion [1] was used. At the formation stage in the EG in the training of future teachers of physical culture, a methodology of natural science training using Moodle was introduced. In the CG the teaching was carried out traditionally. In order to determine the levels of formation of natural scientific competence for future physical culture teachers, which have complex cognitive, activity-based, motivational and personal components, a number of methods was used (Table 1).

Table 1. Methods of determining the formation of natural scientific competence with future teachers of physical education

Competence component	Cognitive	Activity-based	Motivational	Personal
Methods	Testing of students using Moodle	Analysis of the laboratory work results. Testing of educational achievements of students in Moodle	Questioning and using tests for psychodiagnostics by A. Rean (MYH) and K. Zamphir (A. Rean modifiation)	Questioning with testing for psychodiagmostics (methods by J. Johnson, (adaptation by O. Tunyk), V. Andreyeva and M. Grant)

The fourth stage had the synthesis of the study results and formulation of conclusions on the effectiveness of the methodology of natural science training with future teachers of physical culture. The processing of experimental data was carried out using methods of mathematical statistics, in particular, the t-criterion of Student [1] was used. Using methods of mathematical statistics allowed to ensure the reliability of the pedagogical experiment results.

Results

Let's consider the formation of natural scientific competence for future physical culture teachers by using the Moodle methodology.

Formation of scientific knowledge of students as a cognitive component of natural scientific competence, provide informational educational materials of natural sciences in Moodle. In the developed courses, such materials are lectures. Using informational educational materials, the students prepared for a lecture in advance and in the classroom they were already consciously perceiving theoretical material, asked the teacher questions, clarified the inexplicable moments, and so on. In addition, students had the opportunity to check their notes with the electronic version of the lecture and correct the mistakes made. It positively influences the formation of knowledge on natural sciences disciplines, which are mainly studied at the first and second courses in higher education institutions. The students have not yet formed or formed a low level of independent work skills and they are not always able to simultaneously perceive and summarize theoretical material in lectures. In addition, teachers in order to enhance the work of students in advance placed announcements of lectures in Moodle, or links to materials that reveal the importance of the topic for the professional activity of a physical culture teacher. Acquaintance with these materials during self-study trained the students to perceive the lecture and provided an opportunity for teachers to arrange for dialogue or discussion.

In order to assess the formation of scientific knowledge, was performed the testing of student achievements in Moodle. According to the test results, the students were divided by the levels of formation of cognitive component of natural scientific competence (Figure 1).

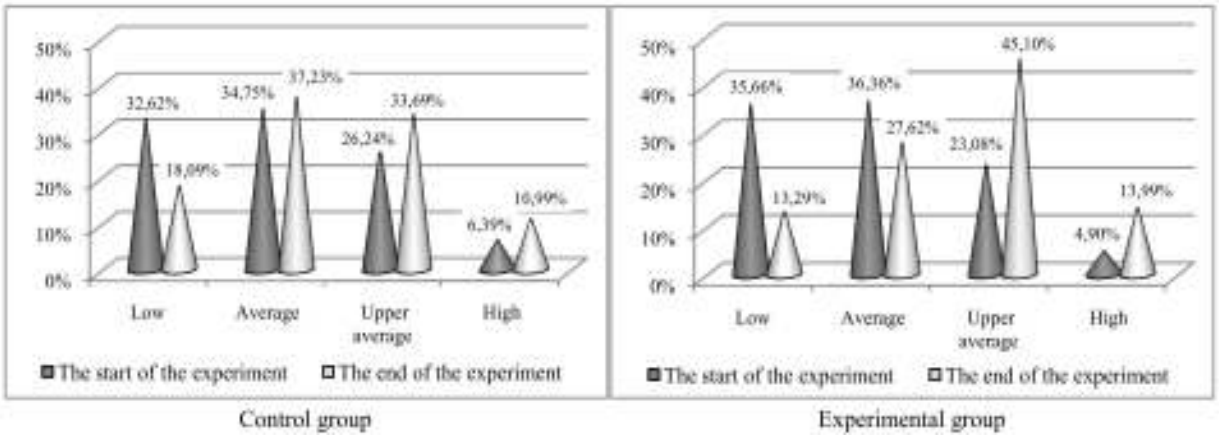

Figure 1. Diagram of the students' division by the levels of formation of cognitive component of natural scientific competence

Diagrams show that the level of formation of the cognitive component of natural scientific competence with future physical culture teachers of EG is higher than that of the CG, which testifies to the effectiveness of the developed methodology of natural science training. We believe that this is due to the fact that the informational educational materials of electronic courses in Moodle provide students with additional opportunities while working with the theoretical materials on natural sciences, provide information support for lectures. It's virtual laboratory work that provides in Moodle the formation of skills and abilities to use natural sciences for practical solution of professional tasks as an activity-based component of natural scientific competence for future physical education teachers. Natural scientific education is the most expensive education, because it requires a certain material and technical base. First of all, it needs laboratory equipment, and in modern economic conditions the institutions of higher education of Ukraine do not always have the opportunity to update it according to the requirements of educational process. This makes it necessary to use educational resources of new generation that provide observation and experimentation in a virtual environment. In addition, many natural objects and processes are inaccessible for direct study in the laboratories of higher educational institutions. In such cases, technologies help to allow virtual experimentation and observation, etc.

During the creation of virtual laboratory work, depending on the features of the discipline, there was used the real equipment or models of the studied objects, processes and equipment. Examples of virtual laboratory work using real equipment are laboratory work on disciplines "Biology" and "Biochemistry". Such work forms with the students the skills of working with modern laboratory equipment. Virtual laboratory works on disciplines "Human Anatomy" and "Human physiology" were developed on the basis of stimulation programs. Such programs visualize objects and processes that cannot be observed under real conditions.

Assessment of the formation of the activity-based component of natural scientific competence was carried out on the basis of student's fulfilment of virtual laboratory work. A test was also conducted using those tests, which included tasks for establishing compliance and the correct sequence, which allowed to determine the level of formation of abilities to use scientific knowledge to solve practical problems. Division of students by the levels of formation of the activity-based component of natural scientific competence is presented in Figure 2.

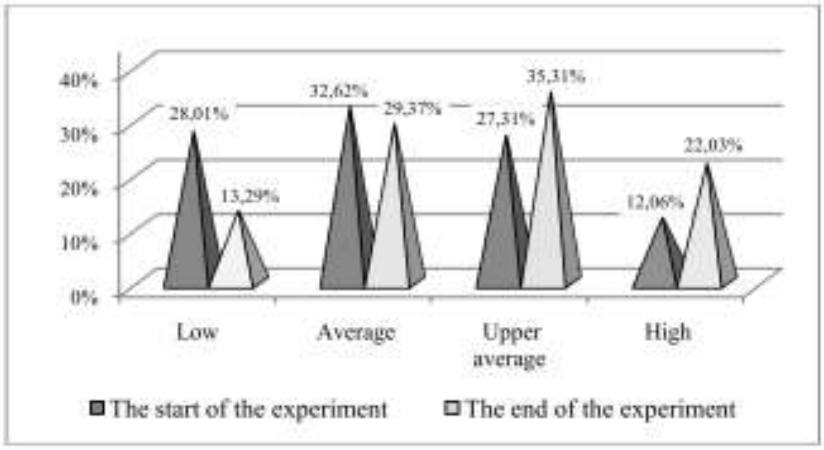

Figure 2. Diagram of students' division by the level of formation of the activity-based component of natural scientific competence

The diagram shows that the level of formation of the activity-based component of natural scientific competence in the EG is higher compared to the CG. We believe that formation of skills and abilities to use natural science is facilitated by virtual laboratory work that enables students to organize and conduct virtual experiment and observation. Virtual laboratory work is constructed in such a way that students can perform their tasks independently, and the role of a teacher is limited to counseling. It increases the interest of students to the subject, the formation of deeper knowledge, better developed skills and abilities, subjective experience in solving non-standard tasks, the ability to work independently and self-education.

The motivational component of natural scientific competence is a combination of motives that motivate a student to study natural sciences, the attitude towards them as necessary for further professional training and practical activities; motives for learning and future professional pedagogical activity.

As a result of the survey used to determine the attitude of students to natural sciences, it was found that 83.0 % of the EG students believe that their professional training should include natural sciences, in the CG the number of positive answers is lower – 64.5 %. Only 71.8 % of students of EG and 53.6 % of CG feel the need for natural science education during the study of vocational training disciplines. The rating of students' responses to the question of the value of natural science training for the future teacher of physical education is presented in Figure 3. The results of the survey indicate that the students of the EG better understand the value of natural science training for future physical culture teachers and more positively relate to the study of natural sciences disciplines, compared to CG students. To assess the changes that took place in the students' motivational area, their motivation for learning and future professional activity was also determined. Division of students by the levels of formation of motivational component to natural scientific competence is shown in Figure 4.

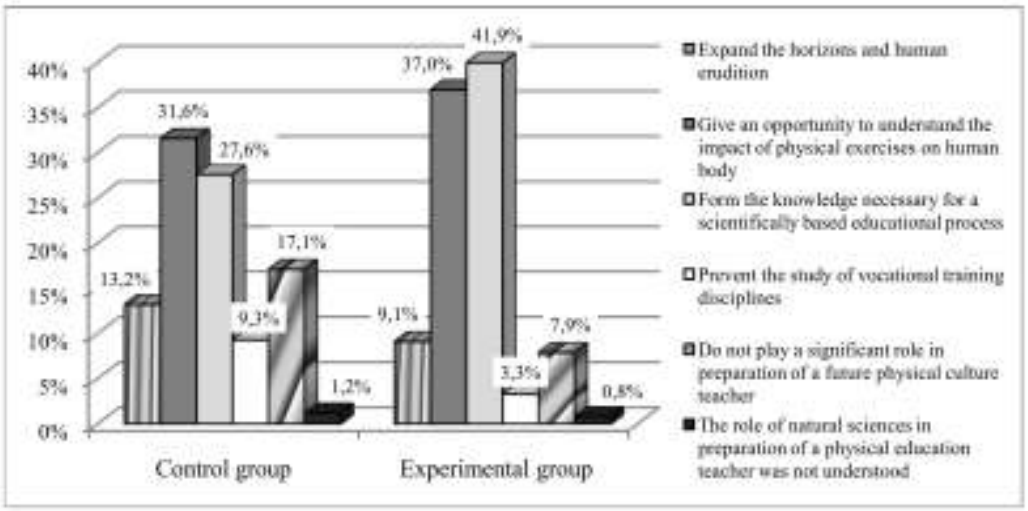

Figure 3. Diagram of division of students' answers to the survey question "What, in your opinion, is the role of natural sciences in preparation of a future physical culture teacher?"

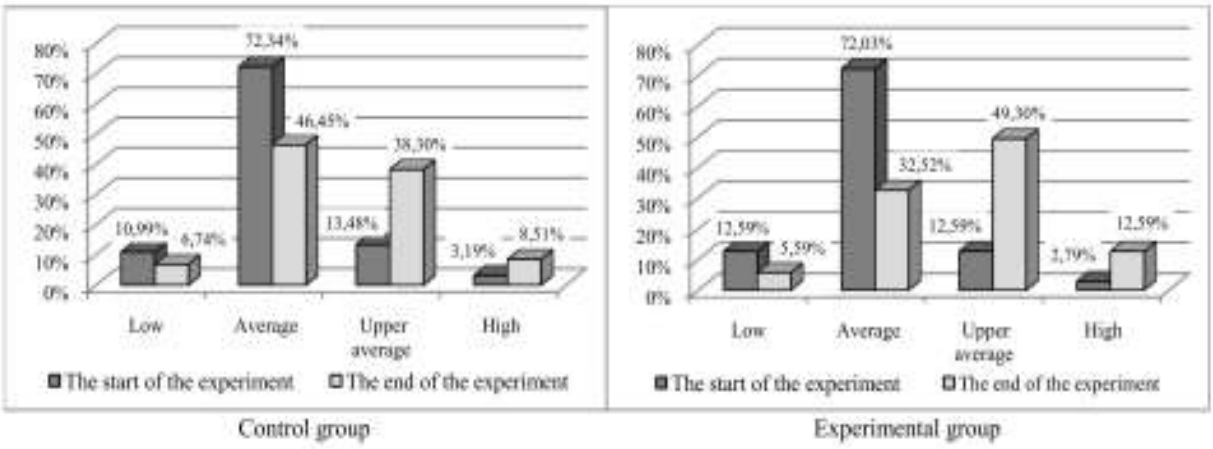

Figure 4. Diagram of division of students by the levels of formation of motivational component of natural scientific competence

As the result of the study, it was found that EG students are more motivated to learning and professional activity than students of CGs. We associate the higher level of formation of the motivation component of natural

scientific competence for EG students with the fact that by using computers and Internet technologies, learning becomes fascinating, makes it possible to research and, as a result, increases the motivation to study. Moodle's opportunities for students to develop sustainable motives to study natural sciences are also facilitated by the following: students have the opportunity to choose a convenient time for independent work; the environment provides students with a wide range of educational resources; students have the opportunity to see the electronic journal with their assessments, which, together with the use of computer testing, ensures transparency and objectivity in the evaluation of educational results; students can communicate with the teacher and other students, which implements the interactive task of participants in the learning process, makes it more active and interesting. Increasing the motivation to study natural sciences and future professional activities also provides professionally directed content of the developed electronic courses in Moodle. Students understand the importance of natural science education for a future physical culture teacher and their learning becomes better motivated. The formation of the personal component of natural scientific competence as individual psychological qualities and abilities important for both a future teacher of physical culture and for a modern specialist in general provides interactive elements of the electronic course.

The developed courses use interactive learning elements – forums, in which students and teachers interact with each other. Also, the formation of a personal component contributes to the fact that Moodle provides an opportunity to effectively organize independent work of students.

To reveal the changes that took place in the personal sphere of future physical education teachers as the result of introduction of the experimental methodology of natural science training, was studied the formation of such personality traits as ability to self-development and self-education, creativity and reflection. The results of the definition of personal qualities were generalized and the students were divided by the levels of formation of personal component of natural scientific competence (Figure 5).

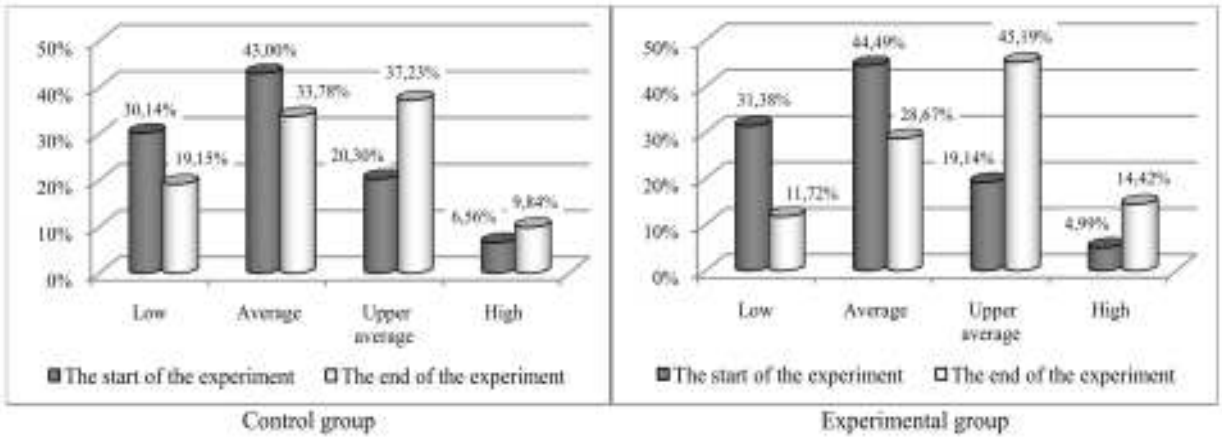

Figure 5. Diagram of division of students by the levels of formation of personal component of natural scientific competence

Diagrams show that in the EG there was a significant increase in the number of students with higher levels of self-development and self-education, creativity and reflection. This is due to the fact that the methodology of natural science training with the use of Moodle has significant opportunities for formation of these qualities with the individual. In particular, the use of forums during the study of natural sciences provides students with the ability to formulate questions, discuss controversial issues and defend their own point of view; unite for solving the tasks; to communicate in a team, to coordinate their actions in accordance with the requirements of other people and working conditions; to evaluate their own academic achievements and the results of the learning activities of other students. It promotes the formation of such personality traits as activity-oriented approach, the ability to comprehend and evaluate their own activities and their results, the ability to work in a team and understand their contribution to the results of activities. In addition, the nature of the teacher-student interaction changes in Moodle.

Communication is done indirectly, through information that virtually eliminates the domination of a teacher over students. Relationships in the educational process become more democratic. Moodle also provides the student with broad access to educational resources, allows them to choose the right time to study and choose their own educational trajectory, which creates the conditions for free development of personality skills in the learning process. It contributes to the activity, autonomy and independence of students.

The generalized data on the formation of natural scientific competence for future physical culture teachers are shown in Figure 6.

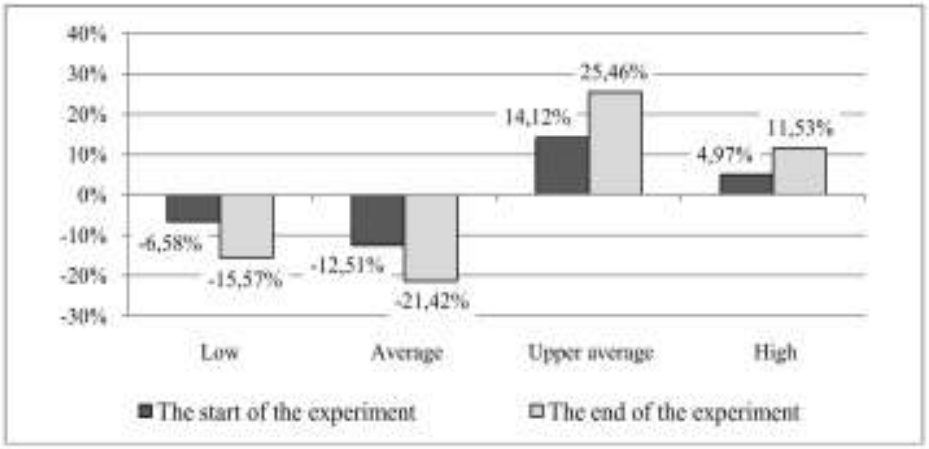

Figure 6. Chart of dynamics of changes in the level of natural scientific competence for future physical culture teachers before and after the experiment

Dicussion

In pedagogical studies considerable attention is paid to the problem of optimization of future physical education teachers in higher education institutions, in particular the formation of readiness for professional pedagogical activity [2; 3] and the pedagogical skills of future physical culture teachers [4], the use of informational technologies and informational educational environments in professional training of physical education specialists [5; 6], development and substantiation of pedagogical conditions for training of future physical culture teachers [7], the training of future physical education teachers on the principles of acmeology [8; 9].

However, the scientific fundamentals for modernization of content and technologies of the scientific training for future physical culture specialists remain practically unresearched. Scientists note that to date, an integrated system of biomedical education has not been developed, the ways of implementing the principle of the unity of theoretical knowledge with the practice of teaching, training, and self-education activities have not been revealed [10]. With the increase of attention to the subjects of humanitarian and professional training, there was a tendency to reduce the percentage of natural sciences disciplines and credits for their study in the structure of training of future physical culture teachers. This situation adversely affected the quality of training and competitiveness of specialists in the labor market, as they are limited in knowledge and technologies that ensure the integrity of the student's perception as an object of pedagogical knowledge and professional activity [4].

At the same time, scientific researches emphasize that natural sciences, in particular biology, are closely related to physical culture and sports, since they describe the natural foundations of different forms of movement and thus constitute the basis for knowledge of human physical activity [11]; natural science training is one of the components for implementation of the acmeological approach in training of specialists in physical education, which involves the use of knowledge on anatomy, general physiologyin the matter of age and sports, ergonomics, etc., as well as research methods developed in these areas of knowledge [9]. The above proves the need to improve the scientific preparation of future physical culture teachers.

In scientific works in order to increase the effectiveness of scientific training of future physical culture teachers in the globalized world, the integration and informatization of modern education systems, it is proposed to apply learning technologies aimed at developing students' ability to continuous professional and personal development, self-development and professional growth throughout life at the expense of realization of their professional and personal acme-qualities [12]; to update the content of natural science training through introduction of integrated courses that provide the formation of biological, medical and health-saving knowledge; to improve organizational forms, methods and means of teaching, to adapt them to the conditions of the educational environment in higher education institutions [10]; to introduce natural science disciplines into the training courses, the content of which is designed with consideration of current achievements of natural science; to apply technologies of personally and socially oriented education [4]; to integrate natural science training and professional training in order to increase the level of physical readiness and the formation of ecological worldview of future physical culture teachers [2]; to realize interdisciplinary connections between biology and physical culture [13]; to introduce in the training of future physical education teachers the learning technologies, developed with consideration of differential approach in education [14]; to use design technologies that provide students with the ability to design physical culture, fitness and mass work at school, implement different types of projects in practice, and find non-standard approaches to solving professional problems [15].

The methodological provisions proposed by the authors on improvement of natural science training of future physical education teachers in higher education institutions [3; 4; 10; 12; 13; 14] are a significant scientific achievement in the field of vocational education. At the same time, they do not fully reflect the requirements of a competent approach that corresponds to the educational paradigm of modern society, do not

take into account the peculiarities of natural science education and informatization in the conditions of the information society. That is why, in order to improve the natural science training of future physical culture teachers, we suggest introducing the methodology, the features of which are: focus on formation of natural scientific competence for future physical culture teachers as the result of their natural science training; use of informational educational environment containing electronic educational and methodological materials for formation and evaluation of natural scientific competence; use of forms and methods of learning that create conditions for the manifestation of autonomy, initiative and creativity of students.

Conclusions

The methodology of natural science training of future physical culture teachers using Moodle is effective in shaping the natural scientific competence of future physical culture teachers, since it increases the motivation to study natural sciences disciplines; ensures the formation of natural sciences skills and abilities to apply them to solve professional problems; develops autonomy, activity, creativity and other personality traits that allow them to succeed in professional activities and social life in general.

As a result of generalization of the pedagogical experiment results, it has been established that in the EG, where the experimental methodology of natural science training was implemented, the number of students with a high level of formation of natural scientific competence increased by 11.53 %, and students with upper average level – by 25.46 % (in CG at 4.97 % and 14.12 %, respectively). Also, in EG, in comparison with CG, the percentage of students has decreased significantly with low and average levels of formation of natural scientific competence. This testifies to the effectiveness of the developed methodology of natural science training of future physical culture teachers using Moodle.

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