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Conditions of formation of a general physical world view in students for the improvement of their future profession

Condiciones de la formación de una visión general del mundo físico enestudiantes para mejorar su futuro profesional

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ABSTRACT:

Environmental problems are one of the main threats to humankind. Therefore, it is necessary to search for solutions to this problem, particularly through education, which gives necessary knowledge and skills. The common mechanisms of interdisciplinary integration of physics and astronomy highlight the connection between physics and astronomy and the most important environmental issues, as well as the mechanism of comprehensive investigation of global environmental problems of Earth and the near space. The purpose of this study is to rationalize the principles of and develop approaches (interdisciplinary integration mechanisms) to the creation of a method of introduction of environmental science in the teaching of physics and astronomy, with a view to improving and forming the professional competence of prospective biologists under the credit-based educational system and improving the professional qualities of students during the learning of the course. In order to achieve the set goal, we used the theoretical analysis of methodological literature on the subject at hand, as well

RESUMEN:

Los problemas ambientales son una de las principales amenazas para la humanidad. Por lo tanto, es necesario buscar soluciones a este problema, particularmente a través de la educación, que da los conocimientos y habilidades necesarias para hacerlo. Los mecanismos comunes de integración interdisciplinaria de la física y la astronomía ponen de relieve la conexión entre estas materias y las cuestiones ambientales más importantes, así como el mecanismo de investigación integral de los problemas ambientales globales de la Tierra y el espacio cercano. El objetivo de este estudio es racionalizar los principios y desarrollar enfoques (mecanismos interdisciplinarios de integración) para la creación de un método de introducción de la ciencia ambiental en la enseñanza de la física y la astronomía, con el fin de mejorar y formar la competencia profesional de los futuros biólogos bajo el sistema educativo basado en el crédito y mejorar las cualidades profesionales de los estudiantes durante el aprendizaje del curso. Para alcanzar el objetivo fijado, se utilizó el análisis teórico de la literatura metodológica sobre el tema en cuestión,

as analysis and generalization of methodological experience. In order to solve the problem of introduction of environmental science, we developed the main mechanisms of interdisciplinary integration – the systems approach, suggested the main approaches to the creation of a method of introduction of environmental science in the physics training course, with a view to developing a systemic view of the world in students, which also serves as the main systemic cognitive model.
Keywords: introduction of environmental science in physics; learning process; subject integration; interdisciplinary research; environmental thinking.

así como el análisis y la generalización de la experiencia metodológica. Para resolver el problema de la introducción de la ciencia ambiental, se desarrollaron los principales mecanismos de integración interdisciplinaria -el enfoque sistémico-, se sugirieron los principales enfoques para la creación de un método de introducción de la ciencia ambiental en el curso de física, con vistas a Desarrollando una visión sistémica del mundo en los estudiantes, que también sirve como el principal modelo cognitivo sistémico.
Palabras clave: Introducción de la ciencia ambiental en física; proceso de aprendizaje; Integración de sujetos; Investigación interdisciplinaria; Pensamiento ambiental.

1. Introduction

Each transition from one sociopolitical order to another necessitates radical transformations in all spheres of the society – socioeconomic, cultural, etc. The educational system of any country at any point in history has always has three main tasks: to teach, to develop, and to educate the younger generation (Ryzhenkov, 1996; Stadnitskiy, 1997; Zverev, 1994). The current stage in the life of independent Kazakhstan is no exception: radical transformations in education have been taking place for years. Previous educational models are changing, new technologies and approaches are sought, and modern value-based criteria are being formed, which already allows connecting the technological process with the problem of humankind and nature.

One of the fundamentals of the formation of new morality and guidelines in the selection of the content of education are environmental values; therefore, a reconsideration of the methodological approaches and techniques of teaching can show the rationality of the ideas of integration in education (Sarmurzina, 2001; Mukhina & Solovyeva, 2004; Mukhamedrakhimova, Shaykheslyamova & Mukhamedrakhimov, 2004). The analysis of the existing approaches to and principles of introduction of environmental science in natural-science education showed that said approaches and principles were heterogeneous and multidirectional, determined by the specifics of the disciplines themselves. The peculiarity is clear: nowadays, the introduction of environmental science can set common guidelines for the rapprochement of disciplines that have already become disconnected and, at the same time, set a course for further development of natural-science education.

In the age of information, the introduction of environmental science in training is a non-depreciating investment that can guaranteed reliable success. The analysis of literature showed that the level of environmental literacy and education of future personnel affects the economic development of the country (Wals 2014; Frantz & Mayer 2014; Stern, Powell & Hill, 2014).

Since 1996, we have studied carefully the current state of affairs in the teaching of natural-science disciplines and have discovered certain difficulties and underdevelopments in the teaching of physics and astronomy. For instance, in higher education non-physics disciplines, astronomical and cosmological knowledge are always relevant. Young people are forced to acquire and accumulate knowledge about astronomy and cosmology from random and often unscientific sources.

At the same time, an in-depth study of the current problems of teaching in this field shows that the teaching of natural-science subjects – physics and astronomy – is already undergoing considerable changes that are caused by a continuous and vast influx of information. Although these academic subjects are designed for teaching young people, the acquisition of such knowledge is often accompanied by certain problems due to said subjects being “conjunctions” of several traditional scientific subjects or due to the subject being closely related to the elements of other equally important subjects – a so-called integration of subjects. This has already been used and is continuing to be used in teaching (Mukhamedrakhimov & Mukhamedrakhimova, 2014; Mukhamedrakhimova & Mukhamedrakhimov, 2014;

Mukhamedrakhimova & Mukhamedrakhimov, 2014a). However, the task of creating a physics course that would integrate astronomy and include environmental science is yet to be set. The reason behind this is the fact that the modern organization of the educational process in Kazakhstan is facing certain difficulties, while a sufficient academic and scientific literature for higher educational institutions in the field of environmental science is lacking. At the current stage, the development of environmental science should be accompanied by environmental education.

One of the main "barriers" on the way out of the environmental crisis is the moral and psychological one. To overcome it would mean for humankinds to realize the spiritual structure of the universe, to change the paradigm of the social sphere and science, and to use the laws of nature. Modern natural-science education allows planning the results of education only when environmental problems already loom large. Meanwhile, environmental protection problems can proceed from technocratic logic: study the phenomenon and use it in production.

Many environmental education experts believe that all natural-science disciplines should include issues of not only environmental protection, but also environmental information in the form of concepts: ecosystem, environmental interaction, environmental opposition, environmental development, and environmental sustainability (Mukhamedrakhimova, Barmakina & Mukhamedrakhimov, 2010; Mukhamedrakhimova & Mukhamedrakhimov, 2014b; Elansky, Kuznetsov & Terekhova, 1998).

In school education in Kazakhstan, such a program is realized by including all natural-science disciplines in the formation of these environmental concepts; however, this approach currently gives unstructured environmental information, i.e. it is random, often in the form of separate examples of environmental problems and disasters. The cause of this problem lies in the development of students and their unpreparedness for the reception of environmental information due to age-related reasons and insufficient information that could be learned at the age of 16-18. Not all senior pupils are mentally capable of comprehending such new concepts. However, it is important that all the information that is produced by environmental education experts be preserved, comprehended, taken into consideration, and developed in the conditions of higher education. Nowadays, in accordance with the global trends, requirements to environmental education are changing constantly – it is no longer enough to be able to determine the source of pollution or develop a project for an industrial company with regard to environmental factors.

The nature of current environmental processes and phenomena is such that any of them will affect multiple aspects of human activities. This requires young people who are receiving a higher education to understand the essence and sources of such problems, know the ways of overcoming the causes of environmental problems, and have experience not only in overcoming the environmental consequences of any industrial activities, but also in preventing such causes.

The level of training of specialists is incomparable to the level of complexity of a proper comprehensive environmental assessment of an industrial facility under construction, while that of a biology specialist – to a proper environmental analysis of existing industrial centers in terms of the environmental pollution level. After all, such an analysis in and of itself requires knowledge from a series of branches of science, engineering, and economics. The most environmentally reasonable approach to the development of skills and abilities and training of prospective biology experts is one where they are involved in the development of new projects at the earliest stages. It is known that a properly organized approach was what allowed developed countries to tackle many environmental problems. Therefore, students should be given such information as examples: about smog in Los Angeles – this city is the birthplace of the term "smog", but its residents have not encountered this phenomenon in their everyday lives for a long time; about the unsuccessful northern river reversal in the USSR; about the resolution of environmental problems (pollution) in the basin of Rhine River, which flows through several countries; about the resolution of problems of air pollution and the ocean pollution with petroleum.

Thus, modern biology experts should know information from many scientific disciplines – ranging from wildlife biology and chemistry of various compounds to modern approaches of mathematical and economic analysis, knowledge about and understanding of cutting-edge industrial equipment, ability to not only use it, but also assess it from the environmental perspective. Already during their student years, they should develop their creative abilities and develop their own projects that meet modern environmental requirements. This is not to speak of the necessity of working with modern computer technologies.

This, in turn, means that emphasis is placed on the fundamental and basic training of prospective biology experts, the significance whereof also stems from the fact that the volume of information about various aspects of the solution of environmental problems grows from year to year. This necessitates the consolidation of interdisciplinary ties, without which it would be impossible to solve said problems. For instance, it is impossible to solve the problem of air pollution without taking into account the physical, chemical, and biological factors: while some of these factors are traditionally considered part of the atmosphere physics, other factors are related to natural compound chemistry, flora and fauna biology. It is necessary to mention the global processes that should be taken into account in astronomy, since in order to understand many processes on Earth, it is necessary to known the original reasons behind this or that property of natural phenomena and objects, the evolution of Earth, the impact of the Sun and the Moon on the atmosphere and hydrosphere of Earth, and, sometimes, the evolution of the entire universe.

The purpose of this study is to rationalize the principles of and develop approaches to the creation of a method of introduction of environmental science in the teaching of physics and astronomy, with a view to improving and forming the professional competence of prospective biologists.

2. Methods

After analyzing the available methodological literature on the subject at hand and generalizing methodological experience, we developed and implemented academic and methodological guides for students on the integrated course of physics and astronomy, a study guide titled Methodological Foundations of the Introduction of Environmental Science in the Learning of Natural-Science Disciplines – Physics and Astronomy – in Higher Educational Institutions that was aimed at improving the profession of biologist, developed a lecture course, carefully selected materials and developed tasks for the independent work of students, created a conceptual model of a physics and astronomy course with the introduction of environmental science based on the integration of disciplines, with a view to improving the profession of biologist, conducted a pedagogical experiment, surveyed students and teachers, conducted interviews and tests, and analyzed the results of the pedagogical experiment.

The accomplishment of such tasks via a comprehensive approach to the solution of environmental problems and interdisciplinary studies are basically a single whole. In turn, the ability to conduct interdisciplinary studies and learn information from diverse sources of scientific literature requires serious fundamental training and profound knowledge about the fundamental natural-science disciplines. Despite the fact that the introduction of environmental science in the educational process imposes strict requirements to students, the process of meeting said requirements can interest the students in learning our course.

For instance, a professional physicist when analyzing a phenomenon automatically links it to the already known phenomena and relates it to this or that branch of physics (optics, mechanics, molecular physics, etc.). Meanwhile, with an environmental thinking, the physicist has to “see” (as opposed to “find”) the process or phenomenon in the general structure of creation. This cannot be achieved by studying separate, albeit fundamental, courses.

3. Data, Analysis, and Results

Such problems are discussed at scientific conferences and workshops, which shows a high demand for the introduction of environmental science in education (Rudneva & Pchelintseva, 2016; Kuzmenok, 1999; Klafki, 1993). It is worth noting that the mechanisms of integration can be different – from interdisciplinary ties to common methodological frameworks. The latter can take a systems approach, which reflects the nature of the new scientific cognition of the world. According to many scientists, the individual and the world have two strategies of interaction: cognition and transformation, with the cognition strategy being the primary one.

In this study, we used both mechanisms of integration – interdisciplinary and systemic – depending on the topic, goals, content, and available means and methods of implementation of environmental knowledge and information. Therefore, in this section of the paper, it is necessary to discuss the methods that are used to optimize the integration of physics and astronomy in education.

Profound environmental knowledge about nature is an important foundation for the development of moral qualities of a young individual's personality, the ability to think on a large scale and predict the possible consequences of human activity for the environment, and develop a new view of nature and intelligent activities in the natural environment.

All phenomena in nature and space play a major role in the life of humankind, while our knowledge of this or that phenomenon are often directly or indirectly related to the practical activities of humankind. Examples from Kazakhstan include environmental disasters at the Caspian Sea, Aral Sea, Lake Balkhash, Semipalatinsk, etc. We believe that environmental problems should be studied by all specialists, not only by environmentalists. The volume of information that has been accumulated over the last fifty years is vast and nowadays, ignoring even a small part of it is no longer possible.

In addition, information about the largescale or even global aggravation of climate conditions, which causes mass mortality of living organisms and severe diseases in humans is also important and relevant. This necessitates careful investigations of the causes of such natural phenomena – it is necessary to understand the origin of such global environmental disasters, be able to determine the damage done to nature, choose solutions to such problems, take into consideration the peculiarity and uniqueness of each specific case from the perspective of at least several most important branches of science, and start teaching this to students. For instance, the Aral Sea crisis, the Semipalatinsk nuclear research experiments, the latest data on the state of the environment of the northwestern part of the South Kazakhstan Region, the natural and agricultural systems in the Ile River basin, mining complexes – by the example of Zhezkazgan, Balkhash, Shemonaikha, landscapes of the Irtysh River area in the Pavlodar Region in the conditions of regulated river flow, the manmade soil pollution from the Aktobe chromium compound plant, the effect of underground nuclear tests on the environment of the Degelen massif, etc. required knowledge of not only astronomy (about the climate, the effect of the Moon, atmospheric phenomena, etc.), but also physics (about atmospheric flows, the temperature regime and temperature changes on the Earth's surface, the light and electromagnetic waves that create unwanted noises) and biology (about the severity of the effect of the above phenomena on living organisms and changes in flora and fauna).

The analysis of studies showed that phenomena that interested researchers the most were not only investigated carefully from the perspective of a specific branch of science, but also required the combined effort of different scientific and academic schools. This enables considering additional conditions when training biology specialists – not only giving knowledge of a particular specialty of biology or biotechnology, but also expanding the horizon of students by adding scientific and educational information to the course of physics and astronomy based on the introduction of environmental science to these disciplines. For prospective biologists, their area of interest is the biosphere, which is also the main object of ecology, physics, and astronomy, albeit under a different name.

Bringing such plans to life is problematic, because it is impossible to continuously adjust the academic program for students by addition scientific information to the academic disciplines of

physics and astronomy. One of the approaches to the solution of this problem is to give biology students this or that information about physics in integration with astronomy and ecology consistently and in brief form. Environmental education experts aim to change the general attitude to the environment and develop a way of thinking that would focus on harmonizing the interaction between the natural and cultural environments. We believe that our approaches will simplify the comprehension of environmental problems. This also rationalizes the need to substantiate the goals of introduction of environmental science in the courses of physics and astronomy. In this study, the necessity of consideration of the goals and estimated results of introduction of environmental science in education is seen in the need to change the individual, his or her culture, science, and the educational system.

Such approaches have turned out to be more effective for the development of a natural-science understanding of the laws of nature. We have started gradually developing academic and methodological complexes on the subject of the research. At the initial stage, students were offered such optional courses as Environmental Issues in the Physics Course during Learning in a Higher Educational Institution and Environmental Issues in the Physics and Astronomy Course for Prospective Biologists. Later, this course was denoted as a physics and astronomy course with the introduction of environmental science on the basis of subject integration for prospective biologists and biotechnologists. This is how we came to the conclusion that the only solution in the current situation is the introduction of environmental science in the process of teaching of physics and astronomy. As the academic and methodological complex of the course featuring the introduction of environmental science was developed, the problem of its implementation in the practice of specialized higher education became more apparent. The problem acquired more distinct “outlines” when a specific goal was set – to improve the profession of biologist based on the introduction of environmental science in the subjects of physics and astronomy and to create unified approaches to the interdisciplinary integration of physics and astronomy based on the introduction of environmental science in the teaching process, with a view to developing the professional competence of prospective biologists.

Thus, the expected competence in the area of the future professional activities of students depends on how they learn the subjects, the content whereof is discussed in this study. This is what occurs in our pedagogical activity: modern economic conditions of development impose new requirements to specialists, their professional training, knowledge, and workplace problem-solving skills. They show the flaws and achievements of the work with the generation of students that are currently engaged in various types of activities, including teaching.

In our course, we tried to demonstrate the content of the ideology that became part of our lives. Therefore, it is possible to indicate the place of the developed physics and astronomy course for biologists in the system of environmental education. This course was aimed:

- at establishing the foundation of an interdisciplinary method of studying natural phenomena based on a holistic worldview;

- at investigating physical and astronomical phenomena, objects, and theories from the perspective of their environmental significance, the knowledge whereof is crucial for biology experts – the formation of the Earth, the atmosphere, the lithosphere and hydrosphere, astronomic prerequisites and conditions of the birth of life on Earth, global natural cycles and phenomena, disasters and patterns, actions and impact of Solar System and space objects on terrestrial phenomena.

The introduction of environmental science in education and the use of innovative technologies in teaching depends on how the students react to it. We had to process vast amounts of academic, scientific, and methodological materials of varying levels of complexity on various branches and subjects. In order to take the proposed course, students had to not only spend more time studying it, but also master it, which required considerable motivation on the part of both the teacher and the students.

The creation of special ecology courses turned out to be a successful project, but the

introduction of environmental science in natural-science disciplines is only beginning to gain traction in higher educational institutions. At early stages, environmental ideas showed that the disciplines that are studied at higher educational institutions were disjointed; their rapprochement turned out to be problematic in both theory and practice. Different approaches to the selection of materials for the physics and astronomy course with the introduction of environmental science predetermined a variety of teaching forms – from active teaching methods to tasks and tests with environmental content. All research and methodological efforts were aimed at ensuring that our study is not a carbon copy of other studies, but an elaboration and continuation thereof. The goal is achieved via the hierarchy principle and consistency in the description of each level of the hierarchy. In order to make the learning and cognitive activity of students more active, we composed the structure of the activity: the forms of methods of active teaching.

The assumption is that it is possible to think somewhat differently: to look for the essence and substance of a phenomenon, object or process, conceptualize a solution, and only then to search for formulas, definitions, algorithms, and samples. This way of thinking is nothing new, but it has become widely used only in the last two decades and is called "nonconventional pedagogical technologies in teaching". This method implies the development of an original approach to a discipline using only lectures and practical and laboratory classes. Nonconventional pedagogical technologies are methods of active teaching in the educational process. The developed active lectures teach students to think independently, make little discoveries, and grasp unexpected thoughts, which makes them active in achieving the goals of learning. To that end, the idea was:

- to not cover all the material on the current topic of physics in its relation to astronomical or environmental issues, but instead to focus on the key problems that are required to understand the essence and master the logic of thinking in practice;

- to supplement and, if possible, expand information about an environmental problem from the perspective of physics and astronomy, to offer theoretical and practical materials on multimedia storage media – electronic guides and courses, materials from scientific channels on the Internet, etc.;

- to encourage students to engage in creative work via research and development activities by offering topic for term papers and essays with subsequent reports to the student audience – this helps to systematize the acquired knowledge;

- to interest students in space research via astronomical thinking, in global environmental problems via computer-assisted or theoretical construction of the events or phenomena that caused disasters and adverse results of human activities (using scientific movies about space and cosmic phenomena, global environmental disasters and problems).

The most commonly used peculiarities of active teaching methods are as follows: active thinking, quick processing of information, active discussion, thematic lectures and discussions, programmed learning, individual creative tasks in the form of computer simulation of physical processes with environmental elements, training and information systems and tables, which allowed generalizing and systematizing acquired knowledge on the topic, independent and practical work. We proposed a clear sequence of academic and cognitive activities of students when studying each topic – this helped the students to learn the materials of the physics and astronomy course, develop their ability to work with academic materials independently, and taught them to observe, explain, and correlate.

The goal of this was to train students to look at all technological processes and natural phenomena from a particular angle: a biology specialist should be able to see the place of any process or phenomenon in the general structure of the universe. This means that the student perceives the interdisciplinary and environmental way of thinking at the earliest stage of training. Students that are ready to learn multiple higher education disciplines are incapable of realizing their true place and significance, which predetermines the differences in their

worldview.

To that end, environmental thinking should be established during the basic training of prospective specialists, where one of the main elements is the physics course. Only this scenario allows developing the professional competence of biologists properly.

In order to solve the top-priority and defining problems of the introduction of environmental science, we developed the main mechanisms of integration – the systems approach as a new type of scientific cognition of the world and set forth the principles of introduction of environmental science in the physics course, with a view to developing a systemic vision of the world in students, which reflects the main cognitive model – the systemic model. To that end:

1. We analyzed the main idea of the research, the main approaches, principles, and methods of pedagogical research, on which the introduction of environmental science in the physics and astronomy course was based, and determined the main mechanisms of integration of this process:

(a) interdisciplinary connections of the natural-science disciplines of physics and astronomy with the most important environmental issues, an integrative academic course of physics and astronomy on the basis of the introduction of environmental science in the education process, and the mechanism of comprehensive consideration of global environmental problems of the Earth and the near space;

(b) a systemic approach in natural-science education, which enabled applying the systemic integration in the learning of the physics and astronomy course based on the introduction of environmental science therein.

2. The systems approach was regarded as not only a subject of research for the purpose of introducing environmental science, but also a means of development and detailed examination of the technology of connection of the three natural-science subjects – physics, astronomy, and environmentalism or, to be exact, the connection of three “events” – the teaching of physics, the teaching of certain fundamental issues of astronomy, and the involvement of environmental knowledge. This showed the psychological level of the students’ perception of astronomy elements in integration with physics based on the introduction of environmental science in education, with a view to improving the level of higher education to the modern level of science. To that end, we developed a special physics and astronomy course with the introduction of environmental science for higher educational institution students, which used mechanisms that developed a systemic way of cognition, set forth new topics, and reconsidered the current topics of physics and the fundamental issues of astronomy with the involvement of environmental knowledge.

Our studies showed that the developed mechanisms of interdisciplinary integration, the consistently presented stages of introduction of environmental science in the teaching of physics and astronomy, and the program for the connection of the subjects of physics and astronomy helped to optimize the methods of integration of physics and astronomy in the teaching process.

When comparing that which the conventional physics courses form to that which should be formed nowadays – in an age of scientific and technological progress and space exploration, but also an age of environmental disasters – we clearly understand that the necessity of radical changes in the methods of specialist training requires treating the existing methodological system somewhat differently and consistently searching for ways to improve the methods of training of prospective biologists in environmental and astronomical physics.

This predetermines a crucial requirement to the approaches and mechanisms of interdisciplinary integration – reproducibility. This means that the methodological system of teaching physics in a higher educational institution, which helps to form the attributes that are inherent in the model of professional activity, should teach the basics of professional mastery, form and improve the profession of not only biologist, but also other specializations. When designing models in our studies and meeting all the requirements thereto, we used the main

cognitive functions – to help set forth and check hypotheses. By using the developed methodology, we attempted to make our pedagogical activity diverse and interesting, while the created principles enabled developing a consistent method of introduction of environmental science in the teaching of physics and astronomy, with a view to improving and forming the professional competence of prospective biologists. This showed good results of improvement of the professional qualities of students at such higher educational institutions of Kazakhstan as the Kokshetau Sh. Walikhanov State University (for 15 years) and the L. Gumilyov Eurasian National University (since 2013). The method was also tested at the A. Baitursynov Kostanay State University and the E.A. Buketov Karaganda State University (since 2008).

4. Discussion

Nowadays, higher education is aimed at forming solid scientific knowledge in students via scientific and practical information; much attention is being paid to the content and real practical attitude of the students to their future professional activity (Stern, Powell & Hill, 2014). The existing problems are typical for the current stage of development of education in general and higher education in particular: insufficient knowledge about physics itself, students' inability to handle the information about modern space research in the world in general and in Kazakhstan in particular during their activities, insufficient educational activities of students, which are aimed to realizing oneself as a subject of professional activity, insufficient self-identification in the profession of choice and development of one's professional position on the basis of reflection on the professional activity. Therefore, the urgent problem is the formation in each citizen of a professional initiative and creativity, the ability to make decisions independently in various situations that can occur in the professional activity of a young individual.

To train a biology specialist means not only to give him or her knowledge within the framework of a particular specialty, but also to expand his or her cognitive horizons by introducing scientific and cognitive information into the physics and astronomy course based on the introduction of environmental science to these disciplines: for instance, area of interest of a prospective biologist is the biosphere, which is also the main object of ecology, physics, and astronomy.

It is possible to teach students (including those majoring in biology) this or that information about physics in integration with astronomy and ecology consistently, clearly, and briefly without adding hours to the curriculum or scientific information to the academic discipline. Therefore, the training of prospective physicists and astronomers based on the introduction of environmental science requires special attention in the modern world.

When developing mechanisms of interdisciplinary integration – the connection of physics, astronomy, and the most important issues of ecology, as well as the mechanisms of comprehensive consideration of global environmental problems of the Earth and the near space, we made an attempt to restore the respect of young people towards the ancient discipline of astronomy. This problem can be solved by transferring some of the issues of astronomy to the physics course, "diluting" them in physics, and showing the importance of the integration of physics and astronomy in close relation to environmental issues.

The integration of several natural-science disciplines implemented the principle of continuous environmental education, which turned out to be a useful approach to the training of prospective biologists. It involved students in discussions on important problems that had different content, which covered a wide range of scientific issues that concern not only physics, ecology, astronomy, and cosmology, but also the axiological sphere of world cognition:

1. When discussing the function of the academic discipline with students, we talk about physics and astronomy as fundamental general scientific disciplines from the natural-science cycle; at that, we explain that physics nowadays is the foundation of scientific and technological process, while its achievements lay the foundation for the main directions of progress, such as

mechanization, power engineering, automation, and new material creation, while astronomy is a science about celestial bodies and Earth, which studies the physical properties and patters of celestial bodies and various forms of existence of matter in space and interactions between them. As it developed over the centuries, astronomy turned into a branched science. The developing industry encourages the exploration of physical, astronomic, and other processes.

2. When discussing the development of astronomy and astrophysics, we talk about their close relation to the achievements of theoretical and experimental physics, the emergence of essentially new research methods, and the possibility of theoretical interpretation of results based on the latest ideas of physics and the fact that all astronomical discoveries prove that nature can be comprehended in all its complexity and diversity.

Although the volume of scientific information in these directions grows at an increasing pace, in astronomy the rapid growth of such information is takin place right now – astrophysics has ceased being a small section of astronomy and turned into a dominating force. However, the achievements of astronomy are so numerous that the presence of unexplained phenomena can make the students doubt the fact that nature can be comprehended by the human mind.

3. When talking about cosmonautics, we reveal to the student audience the vast possibilities for the development of modern methods and means of acquiring new technologies and tools. The importance of exploring space for humankind, the complexity of the emerging problems, and the community of the tasks that are being accomplished stimulate researchers and pedagogues to study the means of gathering and conveying information to the new generations of specialists.

4. When talking about cutting-edge technologies and natural sciences to the students, we say that the technological environment of the industrial society functions based on the laws of nature that were discovered by natural sciences and that the innovative changes in production are hidden deep in natural science.

5. When discussing environmental problems with students, we talk about their resolution via not only the implementation of technical means, but also the reorientation of the human values in regards to nature, about the specific relationships between humankind and nature as a crucial indicator of the level of development of the civilization, when the biosphere is regarded as not only the medium in which humankind dwells, but as the foundation of socioeconomic and sociocultural development. The unity of the planet predetermines the high degree of integration of modern environmental studies, since modern ecology relies on the achievements of virtually all branches of natural science and extensively uses the patterns and principles of various branches of science. However, ecology is different from other sciences, which is why it has not yet reached a stage that would feature a systematized formulation of accurate and specific regularities and patterns. The reasons behind this include such features of environmental materials as complexity, immensity, and considerable irregularity. One thing is certain – ecology is distinctly global nowadays. Thus, we attempt to lead the students to the notion that modern ecology is a complex discipline, which considers issues within the framework of the biosphere ecology in the form of chains: pollution and self-purification of the atmosphere with the greenhouse effect → related to the global warming of Earth’s atmosphere → which results in an increase in the concentration of carbon dioxide; the issues of satellites with the physical methods of monitoring the state of the atmosphere and biosphere on Earth from orbital states; the use of space in biological research.

It is important for the student audience to touch upon the contradictions between the solutions of environmental and economic problems: decades pass from the development of a technology to its implementations. To close factories would mean to leave thousands of people without jobs and the economy of the country – without necessary products, which is why it is necessary to find different ways of solving such problems.

This shows that the phrase “solution of environmental problems” implies the solution of complex issues in the development of both separate manufacturers and entire industries from

the environmental perspective. Such programs are being developed actively all around the world, including Kazakhstan. For instance, we use information about scientific studies on a wide range of issues that are related to the development of environmentally friendly technologies, ways of reducing the level of environmental pollution or elimination of the man-induced impact of industrial facilities on the environment.

We draw the students' attention to the significant gaps in the general level of culture of the society, the neglect for the patterns, regularities, and peculiarities of the living world by young people, and the careless intrusion into the environment, which has already become global and causes worldwide environmental problems. Progressive and modern environmental education and upbringing depend on the organization of the training of prospective specialists. At the same time, a careful attitude to the world is nurtured not only at schools, but also in higher educational institutions (pedagogical, agricultural, polytechnic, etc.); in other words, the study of ecology is an important factor that corresponds with the long-term goal of national and environmental security of Kazakhstan.

5. Conclusion

The data that were obtained during the pedagogical study showed the need to improve the methodological work of teachers in the field of introduction of environmental science in the physics and astronomy course, with a view to improving the professional qualities of students and forming their professional competence. It is necessary to reconsider the issues related to the teaching of not only the general physics course, but also the environmental physics and astronomy course based on interdisciplinary integration, with a view to improving the profession of biologist.

The main value of the environmental factors in the teaching of physics and astronomy was the fact that they gave a reference point for the presentation of complex issues regarding the structure of the world and the universe to prospective biologists, which may come in hand to them in their work as multi-skilled biologists. Despite the fact that these issues are considered by physics teachers at higher educational institutions, the consideration of environmental factors is random. We also performed our teaching activities like this before we faced the need to cover environmental factors in physics classes. We gradually came to realize the problem of biology specialists in the conditions of current environmental factors: any global or local (risk assessment in a specific region) environmental and biological work requires prospective biologists to have good knowledge of both physics and astronomy. Thus, we encountered two aspects of such a problem:

- on the one hand, according to modern requirements to the professional skills of biology specialists, they have to "see the big picture" of any problem;
- on the other hand, it is impossible to provide natural-science training of prospective biologists in a modern level of knowledge without introducing environmental science in the physics and astronomy course based on interdisciplinary integration.

Thus, the modeling of acquired knowledge can be conducted through the physics, astronomy, and ecology courses; the modeling of skills enables using this knowledge effectively and professionally; skill modeling forms ways and methods of using this knowledge in life and professional activities. To that end, we reconstructed the content of disciplines about the world based on a unified methodological systems approach of introduction of environmental science in the content of physics and astronomy with the use of an integration mechanism and created a technology of introduction of environmental science in the physics and astronomy disciplines, with a view to forming the professional competence of prospective biology specialists.

The content of the integrative academic course of physics and astronomy based on the introduction of environmental science in the learning process should aim primarily at solving the most important problems of higher educational institutions: to form environmental culture and responsibility for one's country, the environment, and environmentally friendly lifestyle; to

form and develop the professional competence of prospective biology specialists; to determine the pedagogical conditions and didactic approaches (mechanisms) that would guarantee the effectiveness of the acquisition and application of professional competence. When determining the psychological approach as a logical-psychological component, we used the following main ideas:

1. The learning of knowledge about physics, which are general and abstract, transforms into the learning of specific and concrete knowledge.

2. Students should learn the knowledge about the main parts of the course while analyzing the conditions of their origination, due to which them become necessary.

3. When studying scientific and academic literature, students should detect in the physics and astronomy materials the most essential points that determine the environmental content and the structure of the process, phenomenon or object.

4. Students can recreate this physics and astronomy material with an environmental content in special graphical and literal models, which enable them to see physical and astronomical processes, phenomena or objects in their "pure" but environmental form.

5. Students should be able to specify points of environmental significance in all the information about a phenomenon, process or object, thus showing the unity of the physical, cosmological, and environmental viewpoints.

6. Students should be able to switch from thinking to practical activities to professional activities.

References

Elansky, N.F., Kuznetsov G.I., Terekhova O.A. Diurnal and many-diurnal changes of peroxy radicals concentration under condition of variable industrial Section 1. Near Space and Atmosphere Ecology. Series 3. Physics and Astronomy, Moscow University Mercury, Moscow, No. 4, March, 1998. pp. 13–16.

Frantz C. M. P., Mayer F. S. The importance of connection to nature in assessing environmental education programs. Studies in Educational Evaluation. Vol. 41. 2014, pp. 85-89.

Klafki W. Bildungsperspektiven grundziige internationaler Erziehung. Borrelli M. (Hg.): Deutsche Gegenwartspadagogik. Bd. 1. Baltmannsweiler: Schneider-Verl. Hohengehren, 221S, 1993. pp. 136 - 148.

Kuzmenok, M., A. Library of abstracts and dissertations on pedagogy. 1999, URL: http://nauka-pedagogika.com/pedagogika-13-00-01/dissertaciya-osnovnye-tendentsii-razvitiya-ekologicheskogo-obrazovaniya-v-shkolah-frg#ixzz4nplZnKAs

Mukhamedrakhimov, K.U., Mukhamedrakhimova, G.I. On the formation of natural-science literacy. Proceedings of the Republican Scientific and Practical Conference "The Role of the Skill Upgrading in the Organization of the Professional Growth of Pedagogues in the Conditions of Modernization of Education" Kokshetau, 2006.

Mukhamedrakhimova, G.I., Barmakina, R.V., Mukhamedrakhimov, K.U. Integration in ecology – directions and forms of astronomical studies in Kazakhstan. Study Guide for the Physics and Astronomy Course for Higher Educational Institution Students Majoring in Biology – Kokshetau Sh. Walikhanov State University. Kokshetau, 2010. 170 p.

Mukhamedrakhimova, G.I., Mukhamedrakhimov, K.U. Using integration mechanisms in the physics and astronomy course based on a single systemic methodological approach to the implementation of environmental knowledge. Science and World, Open Academic Journals Index, Scienceandworld RF, Volgograd, No. 2(6), February, 2014. pp. 83-87.

Mukhamedrakhimova, G.I., Mukhamedrakhimov, K.U. Using integration mechanisms in the physics and astronomy course based on a single systemic methodological approach to the implementation of environmental knowledge. Science and World, Open Academic Journals

Index, Scienceandworld RF, Volgograd, No. 2(6), February, 2014b. pp. 83-87.

Mukhamedrakhimova, G.I., Mukhamedrakhimov, K.U., Kenzhaliyev, I.N. Introduction of environmental science in the physics and astronomy course as a means of developing the professional competence of prospective specialists. Science and World, Open Academic Journals Index, Scienceandworld FR, Volgograd, No. 3 (7), March, 2014a. pp. 79-82.

Mukhamedrakhimova, G.I., Shaykheslyamova, K.O., Mukhamedrakhimov, K.U. Some issues regarding the formation of a natural-science concept. A search, Scientific and Pedagogical Journal. Almaty, No. 4, 2004. pp. 48-52.

Mukhina, S.A., Solovyeva, A.A. Nonconventional pedagogical technologies in teaching. Secondary Vocational Education. Rostov-on-Don: Feniks Publishing House, 2004. pp. 384.

Rudneva, L., Pchelintseva, A. The Indicative System of Assessing the Level of Ecologization in the Context of the Region's Sustainable Development// International Journal of Economics and Financial Issues, No. 6(S1), 2016. 227-232.

Ryzhenkov, A.P. Physics and environmental education. Environmental Education: Concepts and Methodological Approaches. M.: Tehnotron Agency, 1996. pp. 54-56.

Sarmurzina, A.G. Interdisciplinarity – the foundation of environmental education in the conditions of sustainable development. AR Scientific and Pedagogical Journal Almaty, No. 1. 2001. pp. 19-21.

Stadnitskiy, G.V. The methodology of environmental education in higher educational institutions. Report Theses of the 3rd International Conference "Environmental Education at Universities", Vladimir, 1997. pp. 35-37.

Stern M. J., Powell R. B., Hill D. Environmental education program evaluation in the new millennium: what do we measure and what have we learned?. Environmental Education Research. Vol. 20. No. 5. 2014, pp. 581-611.

Wals A. E. J. Convergence between science and environmental education. Science. Vol. 344. No. 6184, 2014. pp. 583-584.

Zverev, I.D. Environmental education at school: a concept. M.: Moscow Center for International and Comparative Education, 1994. pp. 32.

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