

Future biology teachers training for professional activity on the basis of sustainable development

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Abstract. The article deals with one of the possible ways of modernization of pedagogical education in Ukraine in order to train teachers of the new generation and to provide conditions for the formation and development of modern alternative models of teachers' professional and personal growth on the principles of sustainable development. The ideas and ways of integrating education for sustainable development and Biology teachers professional training have been determined. It has been substantiated the methodological system of Biology teachers training for professional activity on sustainable development ideas. Its system-forming factor is the idea of combining the activity approach to acquiring knowledge with their ethical reflection, comprehension of personal value in professional and everyday life. The content of the suggested methodological system is made up of the following academic disciplines: compulsory – “Methods of Teaching Biology and Fundamentals of Health Studies” and elective. The efficiency of the corresponding methodological system of Biology teachers training on the basis of quality indicators of the knowledge acquisition (completeness, awareness, consistency and systematicity) has been proved.

1 Introduction

Reforms of the education system in Ukraine, its improvement and quality enhancement caused the necessity of the transition to a new type of humanistic-innovative paradigm of education, which involves the establishment of man as the highest universal human value and his subject-subject interaction with the objects of wildlife. Correspondently there is a need for a significant rethinking of the essence of the educational environment in higher education institutions, structured around certain conceptual dominants generated by changes in the modern scientific picture of the world and value-oriented models of interaction in society [1, p. 123].

The transition to a new nature-oriented education will lead to a reorientation of the value system, in which nature will act as self-worth, man will perceive himself as an element of a single natural community, a part of the system, but not its owner [2, p. 21].

The concept of sustainable development as a leading paradigm of modern civilization has an interdisciplinary nature and is considered in many aspects. It is focused on such a mindset and way of life formation of all the inhabitants of the planet, which will ensure long-term thrifty and harmonious development of Man and Nature [3, p. 9].

The settling of this problem is connected with the content of future teachers training, which is actualized by the need of adjustment the objective and the content of Biol-

ogy teachers professional training to the requirements of the concept of sustainable development.

Thus, the development and substantiation of a methodological system of Biology teachers training for professional activity in secondary schools based on the ideas of sustainable development is *the goal of the article*.

Research tasks:

- to highlight the ideas of the concept of sustainable development, which should be included in the content of future Biology teachers training;
- to identify the ways of integration of education for sustainable development and Biology teachers professional training;
- to develop and substantiate experimentally the efficiency of methodological system of Biology teachers training for professional activity based on the ideas of sustainable development.

2 Methodology

2.1 General background of research

It is generally known, that teachers training must meet the public inquiries formulated in the Concept of Pedagogical Education Development [4], professional standard for teachers of general secondary education [5], state standard of basic secondary education [6], take into account global trends and recommendations of influential international organizations concerning teachers training. The international and Ukrainian program documents formulate

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the basic principles of the concept of sustainable development and the main directions of its implementation, including the environmentalization of public consciousness through the use of education systems and media [7, 8]

The analysis of a number of research results on the relationship between environmental knowledge and attitudes showed that today there is a need for organic inclusion of the system of emotionally-valuable attitudes formation and environmentally responsible behaviour of youth into the higher school educational process [9]. In our opinion, modern biological education should be focused on providing knowledge with value-based sense [10, pp. 6–12].

Many studies have substantiated the need for interdisciplinary and transdisciplinary education for sustainable development [11, 12], the development of universitywide programs of sustainable development [13, 14], as well as models of transnational cooperation of higher education institutions for sustainable development [15]. It is important that education for sustainable development contributes to the formation of key competencies, including the ability to learn throughout life [16].

The problem of education for sustainable development was the subject of research of a number of domestic scientists, who have substantiated the theoretical and methodological principles of implementation of sustainable development ideas in youth education, have developed the concept of the subject “Education for Sustainable Development” studying and its educational and methodological support [17, 18], have developed recommendations on education for sustainable development of adult citizens [19]. However, the problem of developing ways and methodology of Biology teachers training for professional activity based on the ideas of sustainable development has not yet been properly studied.

2.2 Instruments and procedures

To achieve the abovementioned tasks, a number of *research methods* have been used, namely:

- comparative analysis;
- modeling to develop the methodological system for Biology teachers training for professional activity based on the ideas of sustainable development;
- systematization and generalization to highlight the main ideas of the concept of sustainable development, which should be included in the content of future Biology teachers training generalization of pedagogical experience, scientific observation, interviews, questionnaires in order;
- expert assessment, pedagogical experiment quantitative and qualitative analysis of research results using methods of mathematical data processing.

Experimental verification was carried out at Ternopil Volodymyr Hnatiuk National Pedagogical University during 2015–2020. In general, almost 450 students of the Faculty of Chemistry and Biology participated in the survey. 156 students participated in the diagnostic experiment. A questionnaire was conducted to study the opinion of the

students of the second (master’s) level of higher education on:

- the relevance and expediency of the formation of students’ ideas of sustainable development;
- readiness to implement these ideas in the educational process;
- diagnostics of the level of formation of students’ personal attitude to nature and their mindset moral and value orientations (level of personal property).

At the second stage of our experimental methodology we analyzed the achievements of scientists on education for sustainable development; the content of academic disciplines for Biology teachers training and identified the ideas of sustainable development which should be included in the content of methodological training of future teachers. Their expert assessment on the intelligibility and expediency of inclusion them in the content of Biology teachers professional training was conducted.

The obtained conclusions are the basis for the development of a methodological system for Biology teachers training for professional activity based on the ideas of sustainable development. One of the main tasks of the system is to master the knowledge component of professional competence concerning the implementation of education for sustainable development in the content of school biological education. It combines two ways of integrating education for sustainable development in the content of Biology teachers professional training: organization of nature-oriented educational environment in higher education on the basis of the concept of sustainable development in which the model of behavior is transmitted using the method of imitation; carrying out special activities to prepare students for the formation of schoolchildren’s ideas of sustainable development.

We understand the educational environment as the system of influences and conditions of personality formation with a given model of behaviour, as well as opportunities for his/her development, contained in the social and spatial subject surroundings. Corresponding educational environment will contribute to the formation of environmental culture as a factor of sustainable development based on awareness of the value of nature and man as its component. We used methods and techniques of forming a value attitude to nature, aimed mainly at the inner world of the individual, at the process of transformation of the objectively necessary into the subjectively significant. They are realized both during the process of rational cognitive activity and during the emotional and value-based evaluation activity as for the adherence to the principles of sustainable development in all spheres of society. Searches, doubts, excitement should go along with the training, involving all participants in this process. It is obvious that for this it is necessary for the lecturer to rely not so much on knowledge obtained from books, supplemented by personal experience, but on his own knowledge, achieved through suffering in creative pursuits, supported and supplemented by information from books [20, p. 4].

The basis of the training methodology involves humanistic interpersonal communication, partnerships, and

principles of equal dialogue. That is, pedagogical communication is the main mechanism for achieving major goals of education. For this reason, the problem of students' dialogical skills formation becomes actual, which is realized in two interrelated ways: through the organization of the training process in higher education on the basis of partnership in the system "teacher-student" and purposeful activities of future teachers' appropriate skills forming [21, 22].

The conducted analysis of the ways of implementation of the ideas of sustainable development in the content of future Biology teachers professional training [23–25] allowed to highlight the main principles of education for sustainable development. On the basis of their expert assessment, it has been determined that the main ideas of the concept of sustainable development, which should be included in the content of future Biology teachers training are the following:

1. All the elements of the environment regarding nature systems depending on the possibility of consumption or use are divided into two categories: conditions – environmental factors that change in time and space, but are not exhausted; resources – all environmental factors of surroundings, which are consumed or used by all living beings, reducing their number. Man overuses nature, because his super-needs are caused by social character of consumption. Mankind has to live not only in the dimensions of the present, but also be confident in the possibility and stability of its future. All the elements of the environment regarding nature systems depending on the possibility of consumption or use are divided into two categories: conditions – environmental factors that change in time and space, but are not exhausted; resources – all environmental factors of surroundings, which are consumed or used by all living beings, reducing their number. Man overuses nature, because his super-needs are caused by social character of consumption.
2. Mankind has to live not only in the dimensions of the present, but also be confident in the possibility and stability of its future. The issue of the formation of human biosociality is considered in connection with the environment of his life and the causes of the ecological crisis of today (biological, ecological, social).
3. Conditions of natural and anthropogenic environment determine human health, and at the same time the level of development of society (economy, health care, and education) determines the state of health of its population.
4. There exists a direct and inverse relationship between a healthy lifestyle of people and the state of the environment. Healthy lifestyle is environmentally and economically expedient for every person, the state and the planet as a whole.
5. Main principles of sustainable development, which are decisive in constructing the content of both Biology as a school subject and future teachers methodological training respect and care for all living beings and their groups (bio(eco)centrism); improving the quality of human life; preserving the viability and diversity of manifestations of life on Earth; ensuring sustainable use of renewable resources; minimization of depletion of non-renewable resources; change of individual positions and activities.
6. The main constituent elements of education for sustainable development are as follows: self-cognition, self-learning, and independent decision-making in everyday life. The basic idea on which the content and methodology of teaching are built is the following: a student is an active creative individual, capable of cognition and self-development; applying knowledge in practice and imparting the "wisdom of life" knowledge for everyday life to schoolchildren. Possibility to discover and create one's own way of life and own values.
7. Self-analysis, self-criticism and correction of one's own way of life are regulators of the model of behaviour. Human's self-preserving behaviour as a key to his health and well-being ensures adaptation to changing environmental conditions.

The highlighted principles form the basis of the suggested methodological system of Biology teachers training for professional activity based on the ideas of sustainable development.

Experimental methodological system combines three methods to include additional information in the educational process: multi-disciplinary, single-disciplinary, mixed. According to the multi-disciplinary method it is advisable to include material on the issues of sustainable development of nature in the content of compulsory academic disciplines (components) diffusively, in particular "Methods of Teaching Biology and Fundamentals of Health Studies". Along with the environmentalization of the content of academic disciplines, the study of some elective courses of bio(eco)ethical direction has been introduced, namely: "Methodology of "Lessons of Sustainable Development" Course Teaching", "Bioethics and Biosafety", "Ecological and Naturalistic Activities of Schoolchildren". Mixed method involves the study of sustainable development and bio(eco)ethics problems in the combination of multi-disciplinary and single-disciplinary inclusion of additional information.

In addition, it is offered to study the problems of teaching a course "Lessons of Sustainable Development" as a part of teaching methodology of the following courses ("Biology and Fundamentals of Health Studies") [18, pp. 64–85]. It is aimed at the improving of teachers' methodological competence as to the formation of students' habits of environmentally balanced behaviour in everyday life on the basis of value attitude to the environment.

The discipline “Methodology of “Lessons of Sustainable Development” Course Teaching” is included in order to form students’ readiness for education and upbringing on the basis of sustainable development, development of skills and abilities to conduct lessons using training forms, project and research extracurricular and public environmental and educational activities, etc. The syllabus of the discipline consists of two modules [18, pp. 64–73]:

1. Theoretical principles of studying the subject “Lessons of Sustainable Development” in basic secondary school (the main regulations of the Concept of Sustainable Development, peculiarities of the organization of education for sustainable development).
2. Modeling of cognitive activity of the subjects of training in the course of the discipline studying (construction of the content and technology of studying the course for various classes of the basic secondary school).

In the syllabus the studying of problems of methodology of teaching the school subject “Lessons of Sustainable Development” as an element (module) of the mandatory component of Biology teaching methodology there is a list of issues appropriate for preparation for the implementation of ideas of sustainable development. It is planned to study environmental education technology, taking into account the principles of sustainable development, in particular: peculiarities of the pedagogy of “empowerment” (motivation and inspiration for actions) and its role in environmental education and upbringing; methodology of creating eco-teams, conducting lessons, home audits, organization of project and research activities during extracurricular work [18, pp. 84–85].

In general, the suggested methodological system involves the study of the following elective courses: “Methodology of “Lessons of Sustainable Development” Subject Teaching”, “Bioethics and Biosafety”, “Ecological and Naturalistic Activities of Schoolchildren”. Here is a brief description of the disciplines. We will not attract your attention to the peculiarities of the course “Methodology of “Lessons of Sustainable Development” Subject Teaching”, as they have been described above.

The expediency of studying the course “Bioethics and Biosafety” is stated by the fact that without proper attention to bioethical education, any program to implement the ideas of the concept of sustainable development cannot be considered as a holistic formation from the standpoint of pedagogical science. In our opinion, one of the ways to construct a strategy of human behaviour in the biosphere, society and family is to form the young people’s mindset based on the concept of bio(eco)centrism. This is induced by realizing the great life complexity in its terrestrial biosphere boundaries, the catastrophic consequences of its conquest and transformation. However, despite all the global changes in cognition of world creation fundamentals, the essence of life, humanity continues to try to solve problems, based mainly on knowledge of the organismic level of life organization, forgetting about the

system-structural organization of the biosphere, the existence of integral, living systems of higher level of organizations (species, biosphere) on earth [10].

The experience of teaching the course “Bioethics and Biosafety” proved that it contributes to the formation of both general and professional students’ competencies. They involve availability of knowledge about the ways of solving creative tasks connected with the evaluation of the activities of historical figures and the relationship between the subjects of social and natural life in terms of bio(eco)ethical interaction; definition and characterization of different systems of ethical values; strategies of constructive nature-transforming and nature-preserving activity; ability to apply the skills of ecological culture and popularize and instill them in professional and public bio(eco)ethical activities, the ability to make ethically well-considered decisions.

Professional competence includes mastering of different psychological and pedagogical methods of bio(eco)ethical education (identification, reflection, empathy, labilization, fear method, creative therapy, etc.), the ability to apply them in education, to form students’ critical thinking, responsibility for their own actions; the ability to reflect on their own role and actions in nature and society [26, pp. 35–42].

The expediency of including the course “Ecological and Naturalistic Activities of Schoolchildren” in methodological system is caused by the fact that ecological and naturalistic activities based on the ideas of the concept of sustainable development allow to realize the activity component of future teachers’ environmental competence maximally. The main course objectives are as follows: students’ mastering the methods of organizing various forms of extracurricular ecological and naturalistic work, aimed at forming younger generation’s active life position, a conscious attitude to nature; teaching responsibility for the state of the environment, which corresponds to the norms of public morality and law accepted in society; stimulating schoolchildren to practical environmental, educational and inventive work in the field of natural and agricultural sciences. To solve these problems, it is important to master special active and interactive methods of teaching and education, aimed at involving schoolchildren in the search for new effective solutions in obtaining knowledge; teaching conscious participation in teamwork and ways of collective interaction; combination of elements of game and scientific research; teaching to evaluate their own actions and capabilities; use of various sources of information; development of schoolchildren’s creative abilities and interests in various activities for sustainable development [27].

The effectiveness of the suggested methodological system of Biology teachers training for professional activity based on the ideas of sustainable development was tested at the third stage of experimental research (formative experiment). Two groups of students, namely experimental groups (E) and control groups (C) were singled out. During the experiment the students of E groups were taught according to our suggested methodological system (studied a complex of described elective disciplines), and the students of C groups were taught only “Methods of Teach-

ing Biology and Fundamentals of Health Studies” from the block of compulsory disciplines. The first diagnostic survey was carried out at the beginning of the experimental work and the second one after its completion with the aim of determining the effectiveness of the suggested methodological system. The conclusion was made based on the results of checking the level of formation of the content component of future teachers’ professional competence regarding the implementation of the ideas of sustainable development in biological education of schoolchildren of general secondary schools. With this aim we used qualitative analysis of the level of formation of separate quality indicators of the entirely learned knowledge were studied, namely: completeness, awareness, consistency and systematicity. These indicators are most closely connected with the changes in students’ knowledge that they have received during the formation of the content component of future teachers’ professional competence regarding the implementation of the ideas of sustainable development in the educational process of modern secondary school.

The indicator “knowledge completeness” was determined by the amount of all the knowledge about the subject of study (ideas of the concept of sustainable development which were specified by us). Students’ answers were arranged in groups according to the following criteria: complete correct answer; incomplete correct answer; no answer. The indicator “knowledge awareness” is characterized by understanding of links between all the components of the content of education, ways of acquiring knowledge, ability to justify them. Students’ answers were also arranged in three groups respectively: correct answer; incorrect or partly correct answer; no answer. Since, we consider systematicity as precondition of knowledge consistency therefore, the indicators “consistency and systematicity” were studied together. Respondents’ answers were arranged in four groups: correctly correlated concepts of different levels of generality concerning main ideas of education for sustainable development and the ways of their realization; one violation was made in the ratio of concepts; two or more violations were made in the ratio of concepts; no answer. Validity of difference in indicators between separate groups was estimated with the help of χ^2 criterion.

3 Results

The results of the study showed the following: 132 students (84,6 %) believe that the content of academic discipline “Biology”, reconstructed in some way, forms schoolchildren’s mindset on the basis of the concept of sustainable development, 18 students (11,5 %) are convinced that the scientific facts themselves may have educational role, so the teacher does not need to apply upbringing efforts in the classroom, 6 students (3,9 %) think that Biology has nothing to do with upbringing. Answers to the question “What values of nature and universal human values should be brought up at Biology lessons?” showed that 70 respondents (44,9 %) did not answer this question. 86 masters (55,1 %) singled out the following values among the values of nature: the value of each species of living

beings; fauna and flora; the value of nature as a source of knowledge and experience for man; the value of life and admiration of the nature beauty; careful attitude to nature; environmental ethics; the idea that nature is a coherent whole and man is a part of it. The universal human values that should be brought up at the lessons by Biology teachers include: kindness; health; large-heartedness; tolerance; love, mercy; careful attitude to each other.

To diagnose the level of formation of students’ personal attitude to nature and their mindset moral and value orientations (level of personal property), we suggested a questionnaire to identify the relationship between views on nature and morality. 98 students (62,8 %) are aware of the importance of knowledge about the ideas of sustainable development in everyday life, the rest is aimed only at studying the classical content of Biology. Responding the question if the received biological education gives you the opportunity to answer the question “What is life and according to what laws it develops?”, 131 of the surveyed (84 %) gave affirmative answer; 8 respondents (5,1 %) answered negatively; 17 respondents (10,9 %) could not answer. Responding the question “Did it help to answer personal questions about the meaning of life? (your future life, purpose, etc.)” 18 students (11,5 %) answered – yes; 116 respondents (74,4 %) – no; 22 students (14,1 %) answered that they were not interested in such questions. Some respondents take up Biology as an academic discipline that is not related to their real life, they do not realize the prospects of their application in their daily activities.

Thus, the results of the survey showed that the educational process in higher school has significant potential opportunities and prospects for the formation of future Biology teachers’ ideas of sustainable development and their preparation for the appropriate aspect of professional activity.

The effectiveness of methodological system of Biology teachers training for professional activity based on the ideas of sustainable development was tested during the formative experiment in which 448 students (192 students in control (C) groups and 256 in experimental (E) groups) took part.

The results of examination of the effectiveness of the suggested methodological system of Biology teachers training for professional activity based on the ideas of sustainable development, which are reflected in the change of students’ knowledge quality of experimental (E) and control (C) groups, are presented in the table 1.

The obtained data (table 1) according to the indicator “knowledge completeness” allowed determining that the students from experimental groups acquired more complete knowledge. 87,1 % of respondents from these groups gave complete and correct answers. There were only 61,5 % of students who answered in such a way in control groups. 2,0 % of students from experimental groups and 5,7 % of students from control groups did not answer the question.

The students of experimental groups are better aware of the acquired knowledge than their colleagues from control groups. Correct answers were given by 86,3 % of students from experimental groups and 33,9 % of experiment

Table 1. Results of examination of the students' knowledge quality concerning the ideas of the concept of sustainable development

Indicators of knowledge quality	Answer groups	Number of students, whose answers correspond to the arranged groups			
		Control groups		Experimental groups	
		No	%	No	%
Completeness*	I	118	61,5	223	87,1
	II	63	32,8	28	10,9
	III	11	5,7	5	2,0
Awareness**	I	65	33,9	221	86,3
	II	107	55,7	28	10,9
	III	20	10,4	7	2,8
Consistency and systematicity***	I	54	28,1	132	51,6
	II	55	28,6	56	21,9
	III	60	31,3	50	19,5
	IV	23	12,0	18	7,0

* I – correct complete answer; II – correct incomplete answer; III – no correct answer.

** I – correct answer; II – wrong answer; III – no answer.

*** I – correctly compared concepts of different levels of generality; II – one violation has been made in the comparison of concepts; III – two or more violations have been made in the comparison of concepts; IV – no answer.

participants from control groups, respectively. 55,7 % of students from control groups (in comparison with 10,9 % of students from experimental groups) gave incorrect or only partially correct answers about the ways of obtaining knowledge concerning the concept of sustainable development and the means of their substantiation. 10,4 % of students from control groups (in comparison with 2,8 % of students from experimental groups) are not aware of the difference in the ways of obtaining knowledge and the means of their substantiation (indicator “knowledge awareness”).

The analysis of the results obtained according to the indicator “knowledge consistency and systematicity” showed that the quality of knowledge acquisition according to this indicator is higher for students from experimental groups than for those from control groups. 51,6 % of students from experimental groups managed to compare the concepts of different levels of generality in a correct way. In control groups such answers make only 28,1 %. One violation in the comparison of concepts was made by 21,9 % of students from experimental groups and 28,6 % of students from control groups, respectively. Two or more violations in the comparison of concepts were made by 19,5 % of students from experimental groups and 31,3 % of students from control groups, respectively. Also, more participants from control groups (12,0 %) than from experimental groups (7,0 %) did not answer the questions.

For greater reliability of the obtained conclusions, a statistical analysis of the results of the quality of students' mastering the knowledge about the main ideas of the concept of sustainable development and methodology of their implementation in the educational process of modern secondary school was carried out using the criterion χ^2 . It confirmed that to train using experimental methodology enhances the quality of students' mastering appropriate knowledge, which is reflected in the change of students' grades (points), and these changes are not accidental.

4 Discussion

Thus, the conducted study showed that to ensure that education meets the requirements of today, it is necessary to expand the content of disciplines including information about the concept of sustainable development, which would combine the spiritual and material aspects of science that is to “humanize” knowledge. The results of experimental study on Biology teachers training for professional activity based on the ideas of sustainable development testified the effectiveness of the suggested methodological system, the system-forming factor of which is the idea of combining the activity approach to the acquisition of scientific knowledge about nature and the activation of ethical reflection of its laws by students. Its introduction contributes to the creation of an educational environment that allows to increase the level of environmental education of future Biology teachers and to form the ability to implement the ideas of sustainable development in the educational process of secondary schools.

5 Conclusions

We consider that that the study is valuable for the improvement of the system of pedagogical education in general and the natural sciences field in particular regarding the creation of a training base for teachers of new generation with ecological style of thinking based on the ideas of sustainable development, with a high level of responsibility before present and future generations for the results of their activities in natural and social environments.

The suggested methodological system of Biology teachers training for professional activity based on the ideas of sustainable development will contribute to quality of education in higher education institutions, ensure the functioning and development of a competitive market of educational services in the field of professional development of natural sciences teachers.

The prospects for further study consist in the development of motivational-value and activity criteria of the effectiveness of methodological system of Biology teachers training for professional activity based on the ideas of sustainable development. It is expedient to develop methodological systems for training teachers of other academic subjects in the field of science education for professional activities on the basis of ideas of sustainable development.

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