

Developing Environmental Culture in Future Teachers during Professional Training

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Abstract: The paper focuses on the issue of developing an environmental culture in future teachers in higher education institutions. The analysis of relevant findings shows that the issue of developing an environmental culture in future science teachers during professional training is an insufficiently examined segment of pedagogy. This research has attempted to specify and clarify such fundamental concepts as environmental education, environmental culture and development of environmental culture in the context of professional training of future science teachers. The environmental culture of future teachers is seen as an integral personal quality developed during professional training in higher education institutions and based on environmental knowledge and skills, environmental awareness, thinking and behavior which are projected into their professional activities. The process of developing an environmental culture in future science teachers is interpreted as a purposeful educational process, built with regard to general pedagogical patterns and didactic principles, substantiated pedagogical actions and measures (conditions), whose effective implementation leads to qualitative changes in the components of an environmental culture of future science teachers which they need to achieve environmental educational productivity in professional activities. The paper defines the components, criteria, indicators and levels of an environmental culture in future science teachers during professional training. Due to the analysis of scientific literature and practical experience, the paper defines and justifies pedagogical conditions which may contribute to developing an environmental culture in future science teachers. Besides, it presents the author's model for developing an environmental culture in future science teachers during professional training. This model consists of four interrelated blocks: the target block, the theory and methodology block, the pedagogical organization and the results block. Also, the paper reveals the organization and the course of experimental work. Finally, it concludes about the effectiveness of the proposed pedagogical conditions for developing an environmental culture in future science teachers and shows the levels of its development.

Keywords: *environmental culture; future teacher; indicators; criteria; model; professional training; pedagogical conditions.*

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1. Introduction

Given the ever-worsening environmental crisis, one must reconsider the relationship between man and nature rather thoroughly. One of the ways to solve environmental problems is to create a new concept of human interaction with nature, which causes changes in the traditional norms and values of the individual. Consequently, environmental education should be the basis of 21st-century education, which aims to develop an environmental culture in young people.

New vectors in reforms in school education are focused on enhancing environmental training of pupils, which involves elaborating a system of environmental knowledge and widening environmental outlook, developing environmental literacy, thinking, culture, awareness and responsibility. The qualitatively organized educational activities of university teachers and students, which imply a constant search for innovative approaches to teaching, are essential in this process. Hence it is crucial to improve teacher training following the needs of modern schools. Given this, one should pay particular attention to the environmental education of future teachers, which results in a well-developed environmental culture.

Many Ukrainian and foreign scholars have studied the issue of developing environmental culture, outlook, thinking and competency in future teachers. Besides, they have justified the theoretical and methodological principles of these processes in the context of constant professional development. Scholars believe that environmental education aims to develop environmental culture as a set of the practical and spiritual experience of human interaction with nature, which ensures the harmonious development of the individual, society and nature. The most important conditions for achieving sustainable development of society at the global and national levels imply prioritizing humanistic ideals and values in relations between humans and their caring attitude to the environment. The theoretical model for developing environmental conceptions is presented in the article (Ballantyne & Packer, 1996).

Enache, Petrescu, Gorghiu and Drăghicescu (2019) have explored the current conditions and prospects of teacher training in Romania. The paper by Kalungwizi, Gjotterud, and Krogh (2019) is devoted to the participatory action research (PAR) project aimed at improving environmental education in teacher colleges and primary schools in Tanzania. The paper by Espejel Rodríguez and Castillo Ramos (2019) shows the results of Family Environmental Program for baccalaureate students and their families in Mexico. In the article by Chychuk and Kuchai (2017) the

results of comparative analyzing pre-service teachers' training for environmental education in the UK and Ukraine are presented. At the same time, Nikitchenko (2017) has raised the issue of developing professional competency in future biology teachers during their professional training. She has defined the following pedagogical conditions for it: combining theory with practice; boosting students' independent cognitive and research activities; personalizing the goals of professional training. In the study by Sencovici and Pehoiu (2017) the results of the inquiry of students about aspects of the environmental state have been presented.

The possibility of successfully overcoming many crises (including environmental crises) and conflicts in society puts new requirements for education. Indeed, the main goals of education should involve developing personalities through learning; focusing on achieving a qualitatively new level of education for everyone and society; widening the scientific outlook of every pupil and student (Kolomiets, Kolomiets & Hromov, 2017). The paper by Raus (2016) gives the argumentation for the concept of ecological self during teacher education.

The book edited by Corcoran and Wals (2004) provides a history and assessment of the prospects for institutionalizing sustainability in higher education. The aim of the study by Deniz (2016) is to analyze the environmentally aware design education as crucial factor to acquire knowledge through the viewpoint of sustainability. The study by Parrott (2017) proposes to solve the problems of environmental modeling with the participation of stakeholders.

The research by Yezhova, Pashkevich and Manoilenko (2018) found that the curricula of leading fashion education institutions include an environmental component. Of interest is the environmental education of future teachers in the implementation of design projects, described in the article (Mykhyda *et al.*, 2019). The paper by Ge (2017) deals with the problem of the Eco-tourism education effectiveness.

Yachina, Khuzyakhmetov and Gabdrahmanova (2018) have explored the process of developing the regional system of continuing environmental education of teachers. Also, Selles, Montano and Mendez (2017) have considered environmental culture as a process and result of environmental influences that enable a university professor to understand, explain and control cognitive, practical, axiological (evaluative) and communicative activities of his or her students.

The analysis of psychological-pedagogical research and the authors' theoretical search have made it possible to distinguish the following structural elements of environmental culture: environmental knowledge,

environmental thinking, environmental awareness, environmental outlook, environmental ethics, environmental activity (Honcharuk & Honcharuk, 2018).

Environmental culture of future teachers is perceived as a process and result from development of environmental awareness in the individual, reflecting the unity between knowledge, views on nature, emotional and axiological attitude towards it (internal culture) and corresponding abilities, skills, needs of interaction (external culture), based on the harmonization of relationships in the nature-man system (Honcharuk, 2018).

The conducted analysis of findings shows that the issue of developing an environmental culture in future natural science teachers during professional training remains an insufficiently examined segment of pedagogy. Therefore, it is essential to study it in more detail and justify the pedagogical conditions, which may increase the efficiency of this process.

The study of professional activities of science teachers in the field of environmental education, the characteristics of their training in higher education institutions (HEIs) and the results obtained from the analysis of levels of their environmental culture (7.62% of respondents are at a high level at the ascertaining stage of the experiment) prove that there are some *unresolved contradictions* between the objective need of modern schools for active implementation of environmental education and the insufficient level of teachers' environmental training, which decreases the effectiveness of their professional activities; the existing findings on the issue of professional training of future science teachers and the inconsistency of methodological principles for developing their environmental culture; the available potential resources of HEIs regarding the effective organization of training for future science teachers and the lack of scientifically grounded and optimal pedagogical conditions for developing their environmental culture; the need for a particular organization of the educational process focused on developing environmental culture in future science teachers and the fragmentary nature of the content and ineffective forms, methods, tools and methodological support for developing such an essential quality in HEIs.

The paper aims to define, justify and experimentally verify the pedagogical conditions for developing an environmental culture in future science teachers during professional training. In this context, there appears to be a need to develop a model for developing an environmental culture in future science teachers in HEIs.

2. Research methods

The analysis of scientific works on the issue under study has made it possible to determine an environmental culture of future science teachers as the basis of their professionalization and successful professional adaptation. It must be acknowledged that environmental culture is characterized by a system of values and behaviors aimed at preserving the environment and comprehending the responsibility for the consequences of the interaction between man and nature, as well as by the ability to act under environmental imperatives. The characteristics of environmental culture include environmental awareness, thinking, outlook, literacy, ethics and responsibility. The environmental culture of future teachers implies an integral personal quality developed during professional training in HEIs and is based on environmental knowledge, skills, awareness, thinking and behavior, which are projected on their professional activities.

The issue mentioned above can be effectively solved if HEIs provide relevant conditions for professional training of future science teachers and implement the model of such training (*see Fig. 1*).

The authors have employed a set of the following research methods to fulfil research objectives: *theoretical methods* – analysis of scientific literature and legal documents, synthesis, comparison, generalization and systematization of the obtained data to compare different views of scholars on the issue of developing environmental culture in future teachers, clarify the concepts of environmental education and environmental culture of future teachers, determine the components of future teachers' environmental culture, specify the characteristics of teacher training in HEIs, justify the pedagogical conditions; modelling – to build a model; *empirical methods* – a pedagogical observation, surveys; qualymetric modelling – to evaluate the quality of pedagogical conditions; a pedagogical experiment – to verify experimentally the effectiveness of pedagogical conditions for developing environmental culture in future teachers during professional training; *methods of mathematical statistics* – to analyze quantitatively and qualitatively the obtained data and prove their statistical reliability (Pearson's chi-squared test).

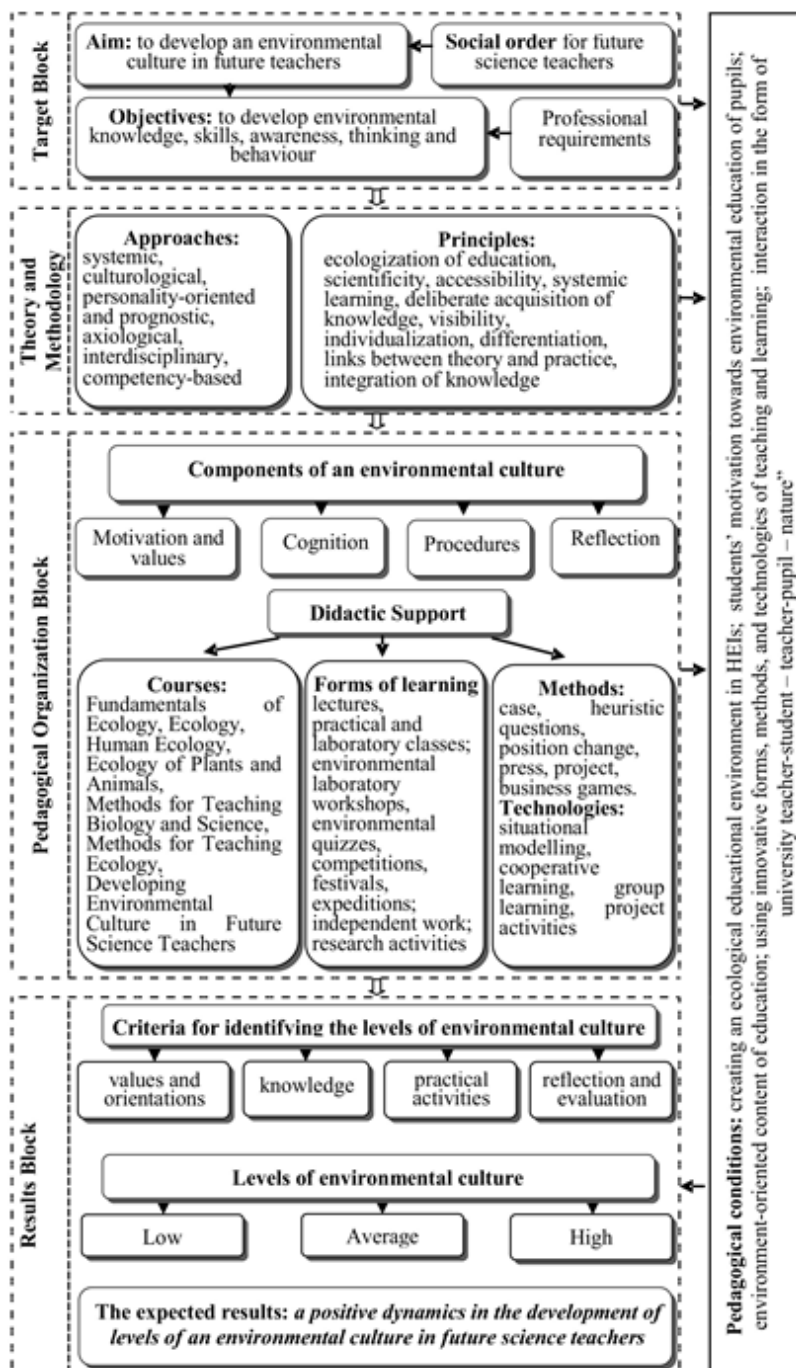


Fig. 1. The model for developing an environmental culture in future science teachers during professional training

The experimental work took place at Pavlo Tychyna Uman State Pedagogical University, the municipal institution “Kharkiv Academy of Humanities and Pedagogy” of Kharkiv Regional Council and Khmelnytskyi National University. At various stages, 328 students participated in the experiment: the control group (CG) – 161 individuals, the experimental group (EG) – 167 individuals. The respondents are to obtain their degrees in the following fields: 01 – Education / Pedagogy: 014.05 “Secondary Education (Biology and Human Health)”, 014.06 “Secondary Education (Chemistry)”, 014.07 “Secondary Education (Geography)”, including such specializations as “Organizing Environmental Measures”, “Ecology”, “Park and Landscape Design”.

The ascertaining stage of the pedagogical experiment aims to identify the characteristics of developing an environmental culture in future science teachers within the traditional system of teacher training, as well as the factors which could increase the level of such culture.

The authors have identified the existing levels of an environmental culture in future teachers at the preparatory stage of the ascertaining experiment. Therefore, future teachers needed to perform specific tasks so that the experimenters could analyze the availability of initial generalized ideas on the issue of environmental culture and the attitude of the teachers towards it. It allowed the experimenters to divide the teachers into EG and CG. After determining the composition of EG and CG, they identified the level of environmental culture in future science teachers based on such criteria as values and orientations, knowledge, professionalism and communication, reflection and evaluation.

Besides, the authors have conducted a self-analysis of future teachers as for the role of environmental culture in professional activities to study the issue of developing an environmental culture in future science teachers (*see Table 1*). This analysis aimed to determine the development level of environmental culture in future science teachers; to outline the issues and contradictions in developing an environmental culture in future science teachers during professional training; to specify the factors in the quality of environmental and professional training of science teachers.

According to the results of such self-evaluation, one can conclude that the respondents from CG and EG have the knowledge, abilities, skills and experience, which are required to conduct environmental activities with pupils from general secondary schools (18.29%), are able to deal with professional situations and tasks and analyze the results of professional activities (18.29-19.21%). They are aware of the specifics of future professional environmental activities and have the motivation to conduct

them (26.22%), as well as the results of their environmental activities (19.21%). They are interested in studying the ecological state of the environment (32.93%). Besides, future science teachers make independent professional-industrial decisions, realize the responsibility for professional results (24.69%), can identify the ways of professional development, self-esteem and correct their professional environmental activities independently (16.77%).

Table 1. Self-evaluation of professional environmental training of future science teachers in HEIs

No	Statement	No, Not at all, %	Maybe, Yes, %	Yes, %
1	Professional environmental knowledge, abilities, skills and experience, which are required to conduct environmental activities with pupils from general secondary schools.	45.73	35.98	18.29
2	Awareness of nature as an independent value.	30.79	41.16	28.05
3	Awareness of the specifics of future professional environmental activities and motivation to conduct them.	43.60	30.18	26.22
4	Interest in studying the environment and solving environmental issues.	35.07	40.85	24.08
5	Ability to deal with professional situations and tasks, analyze the results of professional activities.	50.92	30.79	18.29
6	Ability to perform professional tasks creatively.	46.95	33.84	19.21
7	Independence in decision-making, awareness of the responsibility for professional results.	38.41	36.9	24.69
8	Interest in studying the ecological state of the environment.	32.01	35.06	32.93
9	Awareness of the results of environmental activities.	48.78	32.01	19.21
10	Ability to identify the ways of professional development and Self-esteem clearly and correct professional environment activities independently.	45.73	37.50	16.77

The obtained results show that approximately 25-30% of the respondents are aware of the specifics of future professional environmental activities, motivated to conduct them and interested in studying the environment and solving environmental issues. It proves the severe interest

in studying the ecological state of the environment and developing environmental culture during professional training.

The analysis of the experiment reveals the following main issues in developing environmental culture in future science teachers during professional training: insufficient knowledge and skills to conduct professional environmental activities; inability to deal with professional situations and tasks, analyze the results of professional activities; a low level of environmental culture; inability to analyze and predict professional environmental situations; inability to make professional decisions independently; a low level of professional motivation and creative approach to solving professional environmental issues.

The results of surveys of future science teachers prove that HEIs do not pay enough attention to the issues of developing an environmental culture in such teachers during professional training. The summarized results of the surveys (*see Table 1*) show that only one in ten (12.81%) of the respondents are aware of the importance of environmental culture in their future professional activities. At the same time, 60.67% of the respondents indicate they do not understand the importance of environmental culture in their future professional activities. Finally, 26.52% of the respondents cannot answer the question at all.

The results of the ascertaining stage of the pedagogical experiment prove a low development level of environmental culture in future science teachers. They also make it possible to specify the factors influencing the very process of its, outline the range of theoretical and practical issues, define and justify the pedagogical conditions and build a model of environmental culture (*see Figure 1*).

The professional training of CG students took into account the educational requirements of the syllabi. In the EG, the experimenters have made it possible to optimize professional training of future science teachers through the implementation of the following pedagogical conditions into the educational process: creating an information-oriented and ecological educational environment in HEIs; boosting students' motivation towards professional activities aimed at environmental education of pupils; making the content of education more environment-oriented based on the interdisciplinary integration; using innovative forms, methods and technologies of teaching and learning for enhancing educational and cognitive activities; introducing the interaction in the form of university teacher – student – teacher – pupil – nature” to improve students' practical skills (*see Fig. 1*).

The methods of pedagogical research have identified the existing levels of students' environmental culture based on the relevant system of criteria and their corresponding levels. Also, the experimenters have employed tasks similar to those of the ascertaining stage to compare the data obtained before and after the formative stage of the experiment and draw conclusions regarding qualitative changes in the levels of future teachers' environmental culture. The data on the levels of an environmental culture in future science teachers at the ascertaining stage of the experiment are presented in *Figure 2*.

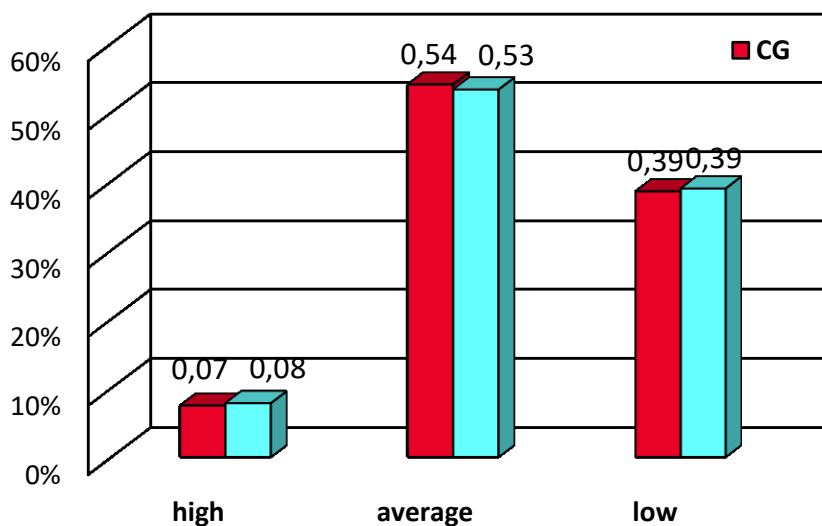


Fig. 2. Distribution of CG and EG students by levels of environmental culture at the ascertaining stage of the experiment (%)

3. Results

Giving the specifics of professional activities of science teachers (a creative combination of scientific potential and psycho-pedagogical skills), the environmental culture of future science teachers is interpreted as an integrative personal quality developed during professional training in HEIs and based on environmental awareness, skills, awareness, thinking and behavior which are projected into their professional activities.

In the course of the research, the authors have determined the components, criteria, indicators and levels of environmental culture in future science teachers. They have found that an environmental culture of future science teachers as an integrative personal characteristic encompasses

motivation and values, cognition, procedures and reflection, which ensure the effectiveness of environmental pedagogical activities.

1. Motivation and values indicate students' awareness of nature as an independent value, as well as their sincere interest in studying the ecological state of the environment.

2. Cognition forms a particular system of psycho-pedagogical, chemical, geographical, environmental, biological knowledge, which can ensure the development of environmental thinking.

3. Procedures imply developing professional environmental abilities, skills and experience which are required to implement environmental activities with pupils from general secondary schools.

4. Reflection involves cognitive skills, norms of environmental behavior, communication and the environmental reflection. It also proves that future science teachers are capable of professional environmental reflection, self-assessment and self-correction of their professional environmental activities.

The authors have singled out specific criteria and indicators to evaluate the levels of environmental culture in future science teachers during professional training. It has made it possible to determine the following levels of an environmental culture in future science teachers: low, average and high (*see Table 2*).

Table 2. Description of levels of an environmental culture in future science teachers

Criteria and their indicators	Levels		
	high	average	low
Values and orientations: the students are interested in studying the environment and solving environmental problems; a constant motivation towards achieving professional environmental goals.	The students have socially significant motives for an intensive exploration of the environment, valuable environmental orientations, realize their involvement in solving ecological problems of the environment, show an interest in conducting environmental activities. They can plan and spread their efforts to achieve professional	The students tend to study the environment, show some interest and willingness to improve their cultural level and are quite motivated towards professional activities aimed at protecting and preserving the environment. They have an average level of value orientations about nature. They have specific views on	The students have no interest and socially significant motives for studying the environment and solving environmental problems. They lack awareness of the value of nature and its uniqueness. They do not so much focus on environmental activities and have a

	<p>environmental goals. They have stable moral and environmental qualities, which are required to learn and cultivate culture, as well as evaluate their environmental, cultural position. They strive for professional development and undertake to develop an environmental culture in pupils.</p>	<p>their responsibility in dealing with environmental situations. They do not mind engaging in professional development and develop their environmental culture.</p>	<p>somewhat formal attitude toward environmental issues. They do not feel the need to develop an environmental culture in pupils.</p>
<p>Knowledge: the students have specific knowledge about science courses and can conduct professional environmental activities in general secondary schools.</p>	<p>The students have professional environmental and cultural knowledge (the underlying patterns, principles, methods, forms, means and techniques), are active and creative, combining theoretical knowledge and teaching methods. They have consolidated knowledge about the specifics of environmental management, standardization, certification and identification. Students regularly update their knowledge and are capable of professional development under new educational requirements. They focus on environmental and cultural activities and can use special methods for modelling and forecasting the state of the environment.</p>	<p>The students have systematic knowledge about psycho-pedagogical and science courses. They are not aware of the interdisciplinary links and cannot always combine theoretical knowledge with teaching methods. They focus on environmental activities and understand the need for environmental protection. They have specialized environmental knowledge and, therefore, can solve some environmental issues, which is necessary for making theoretically and environmentally sound decisions. They show some initiative to gain professional experience in developing an environmental culture in pupils.</p>	<p>The students have superficial professional environmental and cultural knowledge, poor knowledge about methods for teaching science and lack environmental literacy skills. University teachers always supervise their educational activities. They are not aware of the importance of developing an environmental culture. They take a passive environmental position, do not show many initiatives and cannot solve environmental problems. They do not understand the specifics of their future professional activities.</p>

<p>Practical activities: the students have specific abilities, skills and experience which are required to conduct environmental activities in general secondary schools, which are aimed at developing an environmental culture in pupils.</p>	<p>The students have in-depth knowledge which is required to build a vital strategic plan involving environmentally sound activities. They are aware of their responsibility for the state of the environment (they can use relevant technologies to assess it) and develop a clear programme on the preservation of the environment. Using modern methods, they can determine the losses from the air, water and land pollution.</p>	<p>The students can choose their methods for conducting environmental activities. They can solve environmental problems quite well. They have the necessary communication skills to conduct professional activities. They can choose the most optimal ways to overcome the environmental crisis.</p>	<p>The students have poor professional skills, cannot assess the state of the environment, solve environmental problems and overcome the environmental crisis.</p>
<p>Reflection and evaluation: the students are capable of professional environmental reflection.</p>	<p>The students have the necessary leadership qualities and are willing to be responsible for their actions. They focus on environmental problems and are ready to develop an environmental culture in pupils. They understand the need for highly qualified teachers with a high level of environmental culture. They can evaluate their environmental activities and engage in continuing professional development since they strive for professional self-realization and seek to fulfil their optimistic ambitions regarding nature conservation.</p>	<p>The students show environmental initiative, discipline, autonomy, commitment, kindness and can find and evaluate their positive traits, solve unfavorable situations in the team undertaking to solve environmental problems. Based on the generalization of these qualities, the students can self-assess their professional activities and decide whether they have chosen the right profession. They are aware of the need to develop an environmental culture in pupils.</p>	<p>The students cannot evaluate their achievements, autonomy and activity. As a result, they have low levels of theoretical and practical environmental activities and lack persistence in organizing environmental work. They cannot satisfy the environmental and cultural demands of education in their professional activities. They lack leadership qualities, show no initiative and are reluctant to solve environmental</p>

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problems.

The formative stage of the experiment involved the experimental verification of the effectiveness of the following pedagogical conditions for developing an environmental culture in future science teachers: 1) creating an information-oriented and ecological educational environment in HEIs; 2) boosting students' motivation towards professional activities aimed at environmental education of pupils; 3) making the content of education more environment-oriented based on the interdisciplinary integration; 4) using innovative forms, methods and technologies of teaching and learning for enhancing educational and cognitive activities; 5) introducing the interaction in the form of university teacher – student – teacher – pupil – nature” to improve students' practical skills.

The organization of the educational process in EGs served as a holistic system of applying modern innovative teaching technologies, realizing the interdisciplinary links, ensuring the positive motivation of future science teachers and implementing the author's specialized course “Developing an Environmental Culture in Future Science Teachers”. This course has deepened and expanded the students' knowledge about such issues as the primary sources of environmental pollution, environmental problems in Ukraine and its regions, the protection of natural resources in the region and irrational use of natural resources; the ways of developing future teachers' environmental values and developing an environmental culture in them. Also, it has made it possible to develop students' skills in applying the acquired knowledge, implementing practical actions for improving the environment during laboratory and practical classes, regional studies, fieldwork and teaching placement; using the acquired knowledge during observations and independent work on the ecological status of a particular area. In the CG, the educational process followed the traditional system of organizing the educational process in HEIs.

The first pedagogical condition implies creating an information-oriented and ecological educational environment in HEIs. In Pavlo Tychyna Uman State Pedagogical University, they have created Moodle, a free and open-source learning management system (the main page), which has a separate web-page for the course on ecology. It contains all necessary information for the student: the text of lectures, presentations, plans of practical and laboratory classes and relevant methodical recommendations, topics and tasks for independent and individual work, glossary,

recommended reference books, textbooks and manuals, tests for modular and final assessment, exam questions. Such an educational environment helps to realize the following objectives: to meet the needs of students for obtaining environmental information, which is provided by the syllabi of science courses; to motivate the students to update their environmental knowledge, develop environmental thinking and expand their environmental outlook; to use computer technologies in teaching science courses and conducting extra-curricular environmental activities; to create electronic catalogues of educational environmental information and environmental legal documents; to teach the students to use the Internet for performing independent and individual educational tasks on environmental topics; to enable the students to keep track of their progress and increase their rating.

Therefore, the specially designed information and environmental educational environment in HEIs can provide high-quality professional training of future science teachers based on their personal development and environmental culture. Besides, it helps to meet the needs of future teachers in professional development and realization and forms the basis for professional environmental activities.

The second pedagogical condition involves boosting students' motivation towards professional activities aimed at environmental education of pupils. This condition signifies that future science teachers are aware of their motivation toward professional environmental activities. However, HEIs should do the following to implement this condition: to make the educational process more environment-orientated; to improve the syllabi of science courses through introducing environmental topics; to introduce the specialized course "Developing Environmental Culture in Future Science Teachers"; to generate the topics for term papers and qualification works on ecology and other science courses; to involve the students in extra-curricular activities (ecological research expeditions, ecological paths, science holidays); to involve the students in public work that aims to shape environmental thinking and promote a caring attitude towards nature; to build a plan and organize the work of the scientific club "Let's Save Nature". Educational motives are at the heart of motivation towards developing environmental culture, which are defined as a system of students' attitudes towards various aspects of the educational process in HEIs. This system includes environmental needs, interests and socially significant motives that interact closely.

The third pedagogical condition suggests making the content of education more environment-oriented based on the interdisciplinary integration. According to the author's model, the process of developing an environmental culture in future science teachers implied using the selected

forms, methods and technologies of training in the educational process in HEIs (*see Figure 1*). Thus, this process can incorporate the following forms for organizing educational and cognitive activities:

- environmental games, quizzes and mind fights aimed at consolidating the students' knowledge of environmental terms;
- environmental conferences aimed at studying current topics in ecology, as well as finding ways to overcome the ecological crisis and solve various environmental problems in Ukraine and the world;
- environmental competitions (“Save Our Planet Earth”, “Earth is My Home”, “The Gallery of Plants from the Red Book”, “Ways of Preserving Animals from the Red Book”, “We Are for Clean Sources”, “The Best Educational Environmental Path”, “The Best Poster (Photo) of Environmental Topics”, competition of projects on making interior and landscape design of secondary schools more green);
- environmental festivals, reports (“Small Rivers of Ukraine”, “A Fresh Wind”, “In the Camera Glass of a Naturalist”);
- environmental exhibitions (“The Flower Exhibition”, “The Exhibition of New Year's Gifts from Eco-Friendly Materials”, “The Generous Gifts of Autumn”, “Toys from Natural Materials”, photo exhibitions of the best landscapes or greenest cities in Ukraine);
- ecological research expeditions to different areas of Ukraine to identify environmental problems, situations;
- ecological research walking holidays, trips, paths to explore soils, rivers and reservoirs, flora and fauna.

The fourth pedagogical condition means using innovative forms, methods and technologies of teaching and learning for enhancing educational and cognitive activities. The system of professional training for future science teachers cannot be holistic unless it undertakes to develop skills and abilities which are required to conduct environmental activities at school. Under this condition, one should involve future science teachers in practical activities to improve the state of the environment during laboratory and practical classes, fieldwork and teaching placement, regional studies, active use of environmental knowledge during observations and independent study of the ecological status of a particular area.

An integral part of such professional training is fieldwork, during which the students can consolidate and deepen their knowledge of science obtained in HEIs. Future teachers should be well aware of the current state of the geographical location as a whole and the individual landscapes, the trends in their development, as well as be able to observe individual

components of nature, conduct field and route economic and geographical studies and observations.

The students can also apply their knowledge about sciences during teaching placement. Thus, they can observe, analyze and plan environmentally sound activities at school; plan and organize school clubs and nature protection measures (determine the sequence of working with the class, choose effective methods and techniques of working with pupils, organize control over their activities and summarize); conduct individual and collective educational work with pupils aimed at developing their environmental culture. Consequently, they have managed to improve their ability to work with the class, micro-groups of pupils while teaching science, develop their environmental outlook, interest them in solving environmental problems and search for ways to overcome the environmental crisis.

The authors have analyzed the results obtained from the diagnostics of levels of an environmental culture in future science teachers based on the following criteria: values and orientations (motivation and values), knowledge (cognition), practical activities (procedures) and reflection and evaluation (reflection). The overall results of the formative stage of the experiment show that the number of EG students who have reached a high level has increased by 13.17% (from 7.79% to 20.96%). In the CG, this number has increased only by 1.25% (from 7.45% to 8.70%). The number of EG students with an average level of environmental culture has increased by 7.79% (from 53.29% to 61.08%). In the CG, it has increased by 2.48% (from 54.04% to 56.52%). The low-level indicators have changed most significantly. Indeed, the number of EG students has decreased by 20.96% (from 38.92% to 17.96%) and the number of CG students – only by 3.73% (from 38.51% to 34.78%). The findings are presented in *Table 3* and *Figure 3*.

The authors have verified the reliability of the obtained results by calculating χ^2 , a complex indicator, to determine the level of environmental culture (*see Table 3*). The null hypothesis was formulated as follows: the sample data were obtained according to statistically identical populations and therefore any difference in the level of an environmental culture in future science teachers between the EG and CG is the random variation.

According to the formula (1) $\chi^2_{ex}=17.38$. Thus, the obtained results are significant at the level of 5% ($\chi^2_{ex} > \chi^2_{0,05}$). Therefore, the null hypothesis is rejected, and the alternative hypothesis H1 is accepted at a high level of significance. It states that the level of environmental culture in EG and CG students is significantly different, which indicates the effectiveness of using pedagogical innovations. Analyzing the results of the research, one can conclude that the pedagogical conditions for developing an

environmental culture in future science teachers are effective since there are some positive changes in personal characteristics, values and motivation of future teachers. Also, it can ensure their effective professional adaptation.

Table 3. Levels of environmental culture in future science teachers based on the results of experimental work

Group	Stages of the experiment	Levels of environmental culture and the number of students					
		High		Average		Low	
		Number of students	%	Number of students	%	Number of students	%
CG (161)	Ascertaining	12	7.45	87	54.04	62	38.51
	Formative	14	8.70	91	56.52	56	34.78
EG (167)	Ascertaining	13	7.79	89	53.29	65	38.92
	Formative	35	20.96	102	61.08	30	17.96
χ^2_{ex}	experimental					17.383	
$\chi^2_{0.05}$	critical					5.991	

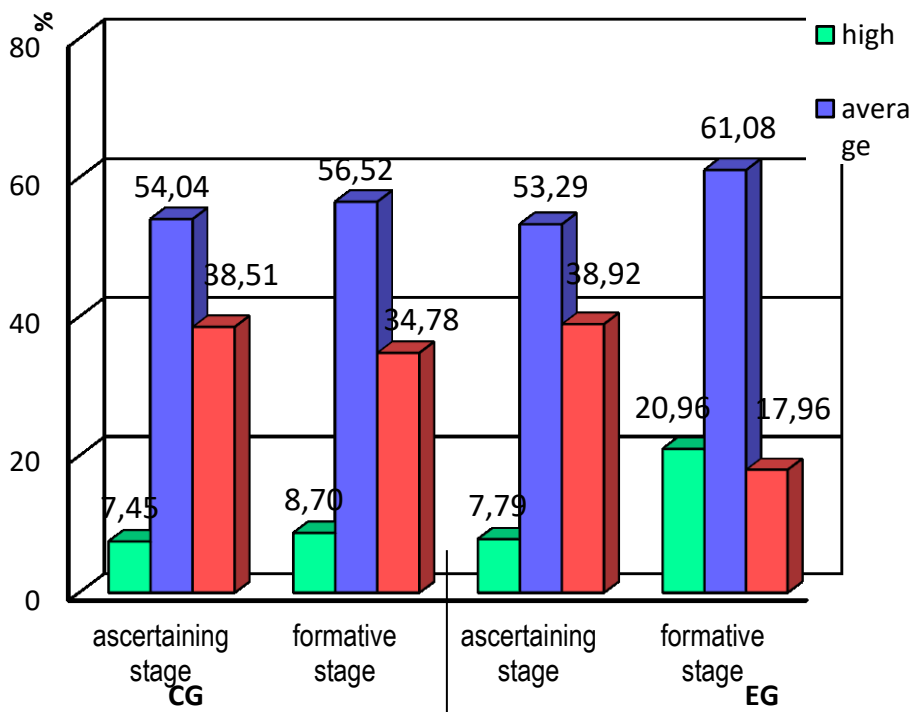


Fig. 3. Dynamics of levels of an environmental culture in future science teachers based on the results of experimental work

4. Conclusions

The analysis of scientific literature and practical experience has determined, justified and experimentally verified the pedagogical conditions which can develop an environmental culture in future science teachers. It has also helped to build the author's model for developing an environmental culture in future science teachers during professional training. The pedagogical experiment has made it possible to verify their effectiveness. The results of the formative stage of the experiment prove that, compared to the ascertaining stage, the number of EG students with a low level of environmental culture has decreased by 20.96% and the number of CG students – only by 3.73%. The number of EG students with an average level of environmental culture has increased by 7.79% and the number of CG students – by 2.48%. The number of EG students with a high level of environmental culture has increased by 13.17%, whereas the number of CG students – by only 1.25%. Thus, one can conclude that the model for developing an environmental culture in future science teachers, as well as the pedagogical conditions, are useful.

Future teachers have realized that their environmental activities with pupils from general secondary schools are an effective means of environmental education for young people. They are convinced that environmental activities aimed at organizing and transforming the natural world under personal needs and intentions must be rational and appropriate. Everyone must necessarily worry about the further development of events that will affect the state of the environment. The well-being of our descendants depends on environmental management. Indeed, the environmentally appropriate behavior is an expression of an environmental culture which is viewed as the type of relationships with the environment, which promotes a healthy lifestyle, sustainable socio-economic development and environmental security of the country.

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