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# ON THE WAY TO ENVIRONMENTAL CULTURE: BOTANICAL GARDEN-BASED CLASSES FOR PHARMACY STUDENTS

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## ABSTRACT

*The increasing public demand for interdisciplinary educational programs in the botanical gardens is much wider and more diverse than required by the curricula of different educational institutions. In this work we present the results of a study conducted as a part of specially organized classes for the students of Pharmaceutical College in Peter the Great Botanical Garden (St. Petersburg, Russia) in 2022. The classes were aimed at developing environmental competences of pharmacy students in the fields of botany, plant ecology, applied ecology and human ecology, in order to improve environmental literacy of the future professionals. The research of this kind is viable and necessary, both for comparing the results, and for the general development of the environmental education (EE). Preliminary research stage, which included diagnostic assessment of the students' subjective attitude towards nature level using Naturaphyl questionnaire, showed that average component values in students of the two groups generally correspond to the average adolescent values. The individual components of the students' attitude towards nature are dominated by the perceptual/affective scale (P/A), proving the aesthetic nature of environmental attitudes. The diagnostic data was used for the methodological work and development of study units using case method. The suggested course of classes in the Botanical Garden shows the effectiveness of environmental education for the pharmacy students.*

**KEYWORDS:** Ecological Culture, Student Pharmacists, Learning, Botanical Garden, Plants, Case Method.

## 1. INTRODUCTION

Nowadays the pedagogical science recognizes the necessity of expansion of educational opportunities, providing students "with the knowledge and skills ... to meet the needs of current and future generations on a local and global level" (Alsharif, 2012, p. 2). It is related to the recent changes in societal demands to institutions holding educational potential, such as botanical gardens. The public need for interdisciplinary educational programs in the botanical gardens is much wider and more diverse than required by the curricula of different educational institutions. At the same time, an important part of educational mission of the botanical gardens around the world is cooperation with educational institutions and promotion of significance of plants and protection of plant biodiversity (He & Chen, 2012; Borsch & Löhne, 2014; Tampoukou, et al., 2015; Mounce, et al., 2017; Chen & Weibang 2018; Ischenko, et al., 2020). Physic gardens hold an important place in on-site educational courses (Tsitsilin, 2016; Devkota & Watanabe, 2020). Today, the physic gardens are used both for the dissemination of the knowledge on the medicinal plants, like the ones used in traditional Chinese medicine (Tkachenko, 2019), and for the comprehensive approach to the plant genetic resource conservation and use for the human benefit (as stated in the goals of the All-Russian Scientific Research Institute of Medicinal and Aromatic Plants), thus enabling development of environmental culture.

In the most recent years, different aspects of the development of the environmental culture in youth are extensively studied around the world. (Deryabo & Yasvin, 1996; Yasvin, 2000; Cheng & Monroe, 2012; Dezhnikova & Ivanova, 2014; Jovanovic et al., 2016; Umnova-Konyukhova, et al. 2021; Tseng, et al., 2021). In Russian literature by the 'environmental culture' we understand general concept comprising process and result of the formation of individual environmental conscience. This implies unity between knowledge and ideas about nature, emotion-, sense- and value-based attitude to it, and proper skills and needs in communication with it, based on the 'nature-man-society' interconnection (Asafova, 2011). The literature study shows that internationally accepted and widely used term 'green culture' is interchangeable by the meaning and content to the term 'environmental culture'. So, in American tradition, "environmental culture" or "green culture" is understood as interaction between society and environment based on the concepts, values, norms and behavioral patterns shared by

individual members of society (Herndl & Brown, 1996). So, the analysis of the perception of natural objects and individual attitude towards are the key for the "green culture" or "environmental culture".

Botanical gardens' strategies in promotion of environmental education, addressing the development of environmental culture of society, embrace various social and professional groups of the population (Kalugin & Musinova, 2021). Thus, the full scope of educational opportunities provided by the collection plots of the Botanical Gardens have a significant potential in teaching to pharmacy students of not only such basic disciplines as Botany and Ecology (Kalugin & Musinova, 2017), but also of highly specialized subjects, such as Pharmacognosy, Ethnobotany and Ethnopharmacology. According to N.L. Etkin a proper study of ethnopharmacology must embrace a broad ecological perspective that is both biobehavioral and multidisciplinary (Etkin, 1988). Another important subject that can be taught is Applied ecology, in particular, prevention of pharmaceuticals emission into the environment, the promotion of sustainable pharmacy and introduction of sustainable pharmacy in the curricula of physicians and pharmacists (Kümmerer, 2010).

When teaching pharmacy students, it is necessary to consider level of environmental culture in planning classes and employing various methods and forms of teaching. In diagnostics of the level of environmental culture, teacher should evaluate the cognitive, motivational-value and activity criteria. For this purpose, two types of criteria are distinguished: the system criteria express the holistic properties of environmental culture, and functional criteria display the properties of individual components of environmental culture. As a rule, the leading criteria of the level of the students' ecological culture development are: motivation for environmental activities, students' behavior in nature; awareness of their responsibility for the state of the environment in the immediate surrounding; comprehensive and versatile environmental knowledge; environmental interests and needs; awareness of the all-around value of nature; awareness of the inherent value of nature; the need to commune with nature; revelation of feelings and emotions in communication with nature; behavior and activities of students in nature; development of practical environmental skills, etc. (Kashlev, 2012). Therefore, the teacher in environmental education is focused of the formation of the personality of a high environmental culture, and therefore, a person with an environmental worldview, which involves "cooperation" with nature.

Many assessment (diagnostic) methods of environmental awareness use scales that measure affective, cognitive and empirical aspects of nature connection (Deryabo & Yasvin, 1996; Deryabo, 1999; Yasvin, 2000; Asafova, 2003; Nisbet, et al., 2009; Mdivani, et al., 2010; Nartova-Bochaver & Mukhortova, 2019).

The data on the psychological assessment of the environmental consciousness of pharmacy, medical and natural science students are necessary for the development of a cognitive, research and practical focus of environmental culture associated with their areas of studies. The data are used for designing educational assignments, tailored to the students' future professional occupation (Butakova, 2018; Zershchikova, 2018; Petukhova & Krivoshapkina, 2019). The teacher's goal is to establish conditions necessary for the development of students' environmental culture and find best solutions to achieving the goals of environmental education.

One of the effective methods of the pharmacy students' environmental culture development is team-based learning. The advantage of this method is in the involvement of students in learning, improving communication skills and developing critical thinking that affects student satisfaction and improves academic performance (Ofstad & Brunner, 2013). The critical thinking skills are essential for the development of the students' competencies in problem solving and discovery, which is necessary in studying natural sciences, for example such topic as Chemical kinetics (Sutiani, et al., 2021) or, focusing geography students on spatial problems (Silvariza, et al., 2021).

Experts also emphasize the value of interactive methods in the biological and environmental education of pharmacy students (Arystanova et al., 2010; Jeronen, et al., 2016; Krikova, et al., 2016; Bokiy, 2017) and the value of the case method in teaching biology and ecology. The case method is highly effective in training and development of the future professionals, since it reduces the number of inactive and insecure students, forms specific personality qualities and competencies, enables the teacher to improve, think differently, act, and refresh creativity (Kolossova, et al., 2018). N.V. Sharypova and N.V. Pavlova, describing successful experience of implementation of the quests and cases in teaching, point out that teaching case is a carefully selected theoretical material that should be as meaningful as possible, contain conflicting data and differing points of view, examine the contemporary issues of biology and ecology (Sharypova & Pavlova, 2018). It is believed that the most effective teaching cases that

promote mental activity are those, in which biological information is not structured, extensive factual information makes it impossible to clearly illustrate the problem and establish the cause-and-effect relationships between individual facts.

## 2. FOCUS OF THE STUDIES

An analysis of the literature showed that at present there is not enough interdisciplinary research on the teaching methods and environmental psychology, including the diagnostics of environmental culture in pharmacy students. The analysis of environmental activities in the BGs does not provide any data in this regard, though such works are being carried out. The analysis of literature data on the building of environmental competencies in pharmacy students by institutions of professional education in Russia is scarce and insufficient. For example T.V. Burtseva, employs "greening" approach to the integration of courses, using ecology and development of integrated educational units as a mainstay (Burtseva, 2009). In other countries, the environmental education (EE) is also criticized for poor research results. This is particularly challenging for EE programs that are implemented in a multicultural environment (Briggs, et al. 2019). Thus, there is every reason to carry out research in environmental diagnostics, and use the obtained data to compare approaches and results with reference to interdisciplinary research. Therefore, this study specifically features assessment and levels of environmental culture.

The second line of our research features pedagogical activities aimed at forming and developing environmental culture in pharmacy students, using case method as a teaching technique. There is reason to believe that the forms of practical ecology and plant ecology acquisition as a part of Botany, Ecology and Pharmacognosy courses, do not sufficiently contribute to the development of students' environmental knowledge, shaping of the methods of environmentally oriented activities, fostering system of values. The study proves the effectiveness of the integration of the Botanical Garden-based course of classes into the professional pharmaceutical education system.

## 3. METHOD

### 3.1. Research Setting

Qualitative and quantitative studies were conducted over two groups of pharmacy students: one at the Pharmaceutical College of St. Petersburg Chemical and Pharmaceutical University (SPCPU) (St. Petersburg, Russia) and one at Murmansk

Medical College (Murmansk, Russia). College students study biology, botany, chemistry, and ecology. The studies were aimed at assessing the developmental level of the attitudinal components towards nature and determination of the promising teaching activities for the development of environmental culture. The Naturaphyl questionnaire, that was developed by S. D. Deryabo and V. A. Yasvin, and used as an assessment tool in our studies, is oriented to the evaluation of the level of ecological and biological knowledge, the strength and breadth of attitudes towards nature, and the dominant attitude (Yasvin, 2000).

The following structural and dynamic characteristics of the attitude towards nature, or the so-called attitudinal scales were taken into consideration for the results interpretation: the perceptual/affective, cognitive, practical, action, and naturalistic erudition scales. The perceptual/affective scale (P/A) is aimed at diagnosing the degree of changes in the system of the personal affectively colored "models" of an aesthetic, ethical and vital character, associated to the relationship to nature. These "models" are expressed by the level of aesthetic and ethical adoption of objects of nature and increased susceptibility to sensual expressive elements. The cognitive scale (C) assesses the degree of nature-driven changes in the motivation and focus of cognitive activity associated with attitude towards the objects of nature. This attitude is displayed by the readiness (lower level) and drive (higher level) to receive, search for and process information on these objects. The practical scale (P) evaluates the degree of changes in the motivation and focus of the nature-oriented activities with objects of nature, determined by the attitude towards them. Such attitude is exhibited in the readiness and drive for non-pragmatic practical interactions with objects of nature. The action scale (A) measures changes in the acts of individuals, driven by the attitude towards nature and expressed in the personal activities aimed at changing the environment in accordance with this attitude. The scale of naturalistic erudition (NE) assesses the body of information on the objects of nature possessed by a person.

**The essence and purpose of pedagogical diagnostics in environmental education is given by S.S. Kashlev and involves:**

- Uncovering and recording changes in the state of the students' environmental culture that is the goal of environmental education, recording the state of the environmental education process itself;
- detecting norms and deviations in the state of the

school students' environmental culture, and in the process of its formation (focusing on standards);

- determining the degree (level) of environmental culture development;
- establishing patterns and causes of the changes in the state of the students' environmental culture, and in the process of the environmental education itself;
- reflecting on and analyzing the facts obtained;
- developing a reasonable and specific plan of further pedagogical interaction for more effective development the students' environmental culture and improving the process of environmental education, based on the obtained diagnostic results (Kashlev, 2012).

In this study, methods of anonymous surveying, observation, educational talks, and comparative and statistical analysis were used. The talks were focused on the importance of plant biodiversity for self-education and personal growth, global plant conservation activities, as well as botanical aspects of the pharmacist's professional skills. Spearman's rank correlation coefficients and Fisher's exact test were used to confirm the reliability of the obtained results.

### 3.2. Data Collection

The study was divided into two stages: preliminary and project. At the preliminary stage:

1. the students were interviewed to assess their self-reported level of environmental culture (the interviews were carried out directly by the researcher);

2. the interviews examining the level of subjective attitude towards nature and analysis of such attitudinal components (scales) as perceptual/affective, cognitive, practical, behavioral and a scale of naturalistic erudition through were carried out. The survey was conducted anonymously by means of questionnaires and Google Forms. The links to the survey pages was distributed to the respondents through the academic coordinators.

At the project stage, the data obtained using method developed by S.D. Deryabo and V.A. Yasvin, was assessed. Based on the results of the assessment, the classes focusing on the correction of the cognitive component were taught.

### 3.3. Population and Sample

At the preliminary stage, we used a specific sample of students studying pharmacy in different educational institutions and in different cities of Russia. The study involved students of 16-17 years of age. A total of 76 students were interviewed, of which 25 - the students of SPCPU Pharmaceutical College in

St. Petersburg, and 51 - students of Murmansk Medical College (MMC). There is no data on the gender of participants, since it was initially known that there was only one male student in each group. At the project stage, an Open Garden project was set up for SPCPU Pharmaceutical College students in a tailored learning environment of the Botanical Garden of Peter the Great. The project included seven classes in four units: Botany (morphology + plant tissue anatomy + systematics), General ecology, applied ecology, Human ecology.

### 3.4. Data Analysis

At the preliminary stage, students' subjective self-assessment (in the form of interview) of environmental culture was analyzed. This was preceded by a talk on the types of environmental consciousness, value system, social relations and norms, possession of knowledge and practical skills aimed at maintaining life support without harming the environment. A three-level scale of high, medium and low scores was used for the interview analysis in both groups. In the group of SPCPU Pharmaceutical College students, 1 participant rated their own level of environmental culture as high, and the remaining 24 participants - as average, none of the participants rated it as low. In the group of Murmansk Medical College students, 45 participants rated their level as average, 6 - as low, none - as high. Thus, most of the students of both Colleges rated their own level of

environmental culture as average. This subjective assessment helped us to determine on the further diagnostic methods that should help to obtain actual values of the subjective attitude level towards nature.

As a next diagnostic technique, we conducted a survey of both groups of students. The methodology we used contained 50 questions on the attitude towards nature (Yasvin, 2000). All questions were to be answered "yes" (+) or "no" (-), except those marked by asterisk (\*) where "don't know" (n) answers were also possible. The questions concerned the students' interactions with both flora and fauna, and their naturalistic erudition. Questions were to be answered instantly, as the initial response best reflects the choice. The participants were reminded that there are no right or wrong answers, and any opinion is valuable for the study.

The results were interpreted using a special key developed by the authors of the methodology (Table 1). The subject's answer coinciding with the key, has been considered as successful, and 1 point was given for it. The 'don't know' answer for naturalistic erudition scale has always been considered unsuccessful. The attitude intensity towards nature was estimated as a total of the scores of the perceptual/affective (P/A), cognitive (C), practical (P) action (A) and naturalistic erudition (NE) scales after conversion of survey scores to stanines, and then to the T-scale. So, attitude intensity =  $P/A+C+P+A+NE$

**Table 1: Key to the Interpretation of Naturaphyl Questionnaire.**

Plants			Animals			Nature				Scales
1.	6.	11.	16.	21.	26.	31.	36.	41.	46.	P/A
2.	7.	12.	17.	22.	27.	32.	37.	42.	47.	C
3.	8.	13.	18.	23.	28.	3.	38.	43.	48.	P
4.	9.	14.	19.	24.	29.	34.	39.	44.	49.	A
5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	NE

After elaboration and interpretation of the survey results, we identified students with different levels of subjective attitude towards nature. A very high level of the attitude was shown by 64% of SPCPU Pharmaceutical College students, while only 25.5% of Murmansk Medical College students showed such level; in terms of high level and above average level numbers there were no significant differences between the colleges; average level was shown by

12% of SPCPU Pharmaceutical College students and by 43.1% of Murmansk Medical College students (Table 2). Evaluation of the indicators of subjective attitude towards nature intensity level using Fisher's exact test revealed the statistically significant differences between the answers of the two groups:  $p$  (no assoc.) = 0.006857 ( $p < 0.05$ ), which means that two groups of respondents are statistically different.

**Table 2: Indicators of the Intensity Level of the Subjective attitude towards Nature in the Studied Groups.**

Sample size	Intensity level

		Very high		High		Above average		Average	
		respondents	%	respondents	%	respondents	%	respondents	%
SPCPU Pharmaceutical College students	25	16	64,0	3	12,0	3	12,0	3	12,0
Murmansk Medical College students	51	13	25,5	7	13,7	9	17,7	22	43,1
Total	76	29	38,2	10	13,1	12	15,8	25	32,9

**Table 3: Diagnostic results for the structural and dynamic characteristics ( $\geq 5$  scale points).**

	Sample size	The share of the attitudinal components (scales) towards nature in the respondents' answers									
		P/A		C		A		P		NE	
		respondents	%	respondents	%	respondents	%	respondents	%	respondents	%
SPCPU Pharmaceutical College students	25	25	100	19	76	21	84	21	84	20	80
Murmansk Medical College students	51	46	90,2	21	41,2	32	62,8	35	68,7	37	72,6
Total	76	71	93,4	40	52,6	53	69,7	56	73,7	57	75

In the Naturaphyl questionnaire, maximum score for each scale is 10 points. When analyzing the respondents' scales with  $\geq 5$  points for each component, data on the predominance of certain attitudinal components towards nature (Table 3) was obtained. In students of SPCPU Pharmaceutical College the prevalence of the perceptual/affective scale (100%) followed by the practical (84%) and action (84%) scales was determined. This means that along with aesthetic and ethical perceptions, these students are ready for practical environment protection activities and looking for non-pragmatic practical interaction with objects of nature. In Murmansk Medical College students, the perceptual/affective (90.2%) and naturalistic erudition (72.6%) scales prevail. The relationship between the perceptual/affective and performance (68.7%) scales was observed. This means that students, along with the aesthetic perception of nature, are knowledgeable of objects of nature and look for non-pragmatic practical interaction with

them. It is possible that Murmansk students' answers and attitudes towards nature are influenced by them living beyond the Arctic Circle, where climatic conditions are more severe than in St. Petersburg. However, in both groups, the cognitive component is insignificantly low (76% in SPCPU Pharmaceutical College students and 41.2% in Murmansk Medical College students). Spearman's rank correlation coefficient revealed a strong positive correlation ( $R=0.73849$ ,  $p<0.001$ ) between the cognitive and practical scales (Table 4). There is a weak correlation ( $<0.5$ ), between other scale indicators. Among them, the strongest correlation is found between naturalistic erudition and high scores on the cognitive scale (0.24138,  $p<0.001$ ).

Each of two samples was divided into two groups: participants with values of  $\geq 5$  points and of  $<5$  points for each scale. Fisher's exact test was applied to both samples. The samples are statistically significantly different (0.0066843) only in terms of the cognitive attitude towards nature.

**Table 4: Interrelationships between scales according to Spearman's Rank Correlation Coefficient.**

	P/A	C	A	P	NE
P/A		0,00015752	0,00016066	0,036276	0,097582
C	0,42019		2,67E-14	4,48E-05	0,035675

A	0,41969	0,73849		1,32E-05	0,10548
P	0,24062	0,45026	0,47707		0,39239
NE	0,19145	0,24138	0,18715	-0,099514	

**Table 5: The difference between Respondents who Scored  $\geq 5$  and  $< 5$  points for each Scale.**

Attitude towards nature, value in points	SPCPU Pharmaceutical College students	Murmansk Medical College students	Fisher's test p (no assoc.):
P/A $\geq 5$	25	46	0,16495
P/A $< 5$	0	5	
C $\geq 5$	19	21	0,0066843
C $< 5$	6	30	
A $\geq 5$	21	32	0,067979
A $< 5$	4	19	
P $\geq 5$	21	35	0,17772
P $< 5$	4	16	
NE $\geq 5$	20	37	0,57994
NE $< 5$	5	14	

The project stage included a system of classes for SPCPU Pharmaceutical College students on the units and topics indicated in Table 6. Given the lower cognitive component indicator values, the emphasis was put on the development of environmental knowledge. To achieve the goals of the study, a number of teaching methods were applied, the case method being the leading one.

The proposed conceptualization of ecological knowledge through the system of Botanical Garden-based classes includes analysis, synthesis, comparison, abstraction and generalization of the information received as a result of case method application. The case method major objective is to develop students' ability to understand the consequences of environment-related activities, their reflective capabilities and future professional expertise. The effective cases provide students with the opportunity to gain insights into the problem and come up with reasonable solutions. It is important that there is no single solution to the case, and the teacher does not intervene in the discussion.

The system of the study cases that has been

developed for the project, was focused on making students understand the vital importance of plant biodiversity, developing the ability of future pharmacists not only to identify and classify plants, forming attitudinal components towards nature using wide resource possibilities of an urban academic botanical garden. The incorporated methodical basics made it possible to map out the course and develop principles for implementation of environmental culture fostering. These basics include the regulations on botanical gardens and on various forms of professional training in them, on biological diversity and environmental protection, as well as the Convention on Biological Diversity (1992) and the EU Biodiversity Strategy until 2030.

To achieve educational goals, we adopted the unit studies approach, integrating different areas of knowledge to teach specific topics (Table 6). Each lesson included an introduction to the living collections, practical work and a case that students should solve individually or in a group. Each topic was meant to be taught over two teaching hours (45 minutes each).

**Table 6: Topics of the study units delivered to the students during Botanical Garden-based classes.**

Unit	Topics	Teaching activities	Plants studied
Botany	Plant morphological characters and their association with natural habitat characteristics	Subtropical greenhouse trail tour; practice; individual cases; role play	<u>Species in the genera:</u> <i>Citrus</i> L., <i>Hippeastrum</i> Herb., <i>Passiflora</i> L., <i>Muehlenbeckia</i> Meisn. <u>Species:</u> <i>Musa basjoo</i> Siebold & Zucc. Ex <i>linuma</i> , <i>Ruscus colchicus</i> Yeo, <i>Euphorbia canariensis</i> L., <i>Colletia paradoxa</i> (Spreng.) Escal. and others
	Plant taxonomy (illustrated by family Cactaceae)	Tropical greenhouse trail tour with assignments; practice with succulents;	<u>Species in the genera:</u> <i>Cycas</i> L., <i>Opuntia</i> (Tourn.) Mill, <i>Mammillaria</i> Haw., <i>Cereus</i> Mill., <i>Echinopsis</i> Zucc. <u>Species:</u> <i>Opuntia microdasys</i> (Lehm.) Pfeiff.,

		role play	<i>Opuntia ficus-indica</i> (L.) Mill. and others
Plant ecology	Diversity of plant ecological groups. Effect of anthropogenic factors on plants	Quest 'EcoTropics' along the Tropical greenhouse trail; practice; role play	<u>Species in the division</u> Polypodiophyta <u>Species in the genera:</u> <i>Euphorbia</i> L., <i>Aloe</i> L., <i>Begonia</i> L., <i>Cypripedium</i> L., <i>Cattleya</i> Lindl., <i>Oncidium</i> Sw. <u>Species:</u> <i>Platyserium bifurcatum</i> (Cav.) C.Chr., <i>Salvinia natans</i> (L.) All., <i>Adansonia digitata</i> L., <i>Tetrastigma voiniarianum</i> (Baltet) Pierre ex Gagnep., <i>Coffea arabica</i> L. and others
Applied ecology	Plant biodiversity conservation Environmental protection	Interactive excursion around the arboretum of the Botanical garden and Subtropical greenhouse trail; practice; role play	<u>Species in the family:</u> <i>Ericaceae</i> Juss., <i>Cupressaceae</i> Gray <u>Species in the genera:</u> <i>Callitris</i> Vent. <u>Species:</u> <i>Araucaria araucana</i> K.Koch, <i>Cibotium barometz</i> (L.) J.Sm., <i>Dicksonia sellowiana</i> Hook., <i>Cedrus libani</i> A.Rich., <i>Sequoia sempervirens</i> (D.Don) Endl., <i>Dionaea muscipula</i> J.Ellis, <i>Metasequoia glyptostroboides</i> Hu and W.C.Cheng, <i>Magnolia delavayi</i> Franch., <i>Buxus colchica</i> Pojark., <i>Sequoia sempervirens</i> (D.Don) Endl. and others
	Impact of plants on environment and climate	Walk along Subtropical greenhouse trail with route activity sheet; practice; role play	<u>Species in the division</u> Polypodiophyta <u>Species in the family:</u> <i>Zamiaceae</i> Horan., <i>Arecaceae</i> Bercht. & J.Presl <u>Species in the genera:</u> <i>Cycas</i> L., <i>Euphorbia</i> L., <i>Opuntia</i> (Tourn.) Mill., <i>Mammillaria</i> Haw., <i>Cereus</i> Mill., <i>Echinopsis</i> Zucc., <i>Pachypodium</i> Lindl., <i>Bambusa</i> Schreb., <i>Schefflera</i> J.R.Forst. & G.Forst., <i>Aspidistra</i> Ker Gawl. <u>Species:</u> <i>Psilotum nudum</i> (L.) P.Beauv. and others
Human ecology	Fundamentals of phytodesign: effect of plants on human health	Quest 'EcoSubtropics' along the Subtropical greenhouse trail; practice; role play	<u>Species in the genera:</u> <i>Juniperus</i> L., <i>Citrus</i> L., <i>Myrtus</i> L., <i>Aucuba</i> Thunb., <i>Cupressus</i> L., <i>Nerium</i> L., <i>Euonymus</i> L., <i>Rosmarinus</i> L., <i>Pelargonium</i> L'Hér. ex Ait., <i>Kalanchoe</i> Adans., <i>Laurus</i> L., <i>Ficus</i> L. and others
	A "new lease of life" for plants	Walk along Tropical greenhouse trail with route activity sheet; practice; role play	<u>Species in the genera:</u> <i>Philodendron</i> Schott, <i>Carica papaya</i> L., <i>Ananas comosus</i> (L.) Merr., <i>Ficus</i> L. and others <u>Species:</u> <i>Monstera deliciosa</i> Liebm., and others

The sample teaching case for a topic "Impact of plants on environment and climate"

Introduction to the case. Botanical gardens around the world can contribute to atmospheric CO<sub>2</sub> reduction through their activities. The Jardin Botánico de Medellín (Colombia) has developed a sustainable business mobility plan aiming at reducing carbon emissions. The plan includes steps for encouraging staff to use bicycles for commuting to work. Each employee has a unique code installed on their bike (similar to license plate). By registering this code, the garden can record the number of bicycle rides by each employee. As a stimulus and reward, cyclists are given 1 day of annual leave per 40 days of cycling. In addition, to encourage commuting by bicycle, 57 staff bicycle parking spaces have been provided within the Garden. Furthermore, an annual bike fair is held to promote green commuting among the staff. In 2019, 70 employees of the Jardin Botánico de Medellín took advantage of the scheme and registered 3,970 trips (from BGC

Technical Review, 2020).

Role 1. You are the director of the Botanical Garden of St. Petersburg (Russia). Would you use this method of reducing CO<sub>2</sub> emissions? Would you offer it to the employees?

Role 2. You are the Botanical Garden's employee. Would you engage in this CO<sub>2</sub> reduction method?

Group assignment: On average, a daily commute by passenger car, requires burning 15 liters of fuel and releases about 35 kg of CO<sub>2</sub>. How many kilograms of CO<sub>2</sub> would not have been released into the atmosphere if the Botanical Garden's employee has not used the car on weekdays in 2021?

In Russia, it is fairly common to determine the students' degree of individual personality development in the area of ecology using criteria for levels of environmental competencies. Three criteria – the cognitive, value and activity/practical and their characteristics were used for interpreting the preliminary results of the project developed for college students. It should be pointed out that most

of these criteria are functional, or reflect individual properties of environmental culture.

The following knowledge and skills were assessed for each topic:

A. The level of botanical awareness (degree of the orientation in the studied plant morphology, plant tissue anatomy, plant taxonomy, knowledge of botanical nomenclature: Latin family and species names of the studied plants)

B. The level of applied ecology awareness (knowledge of the factors and conditions that affect environmental systems).

C. The level of plant ecology awareness (knowledge of environmental factors affecting plants, knowledge of the plant ecological groups in relation to natural factors).

D. Willingness to analyze information sources, enabling to determine ways to the resolution of environmental problems.

E. Willingness to elaborate proposals for problem solution based on the problem statement and obtained information

F. Willingness to identify key conditions for solving the problem

G. Leadership, teamwork.

H. Motives for environmental protection as a part of future profession.

I. Naturalistic erudition.

J. General scientific erudition.

Each lesson outcomes were directly interpreted by the researcher and evaluated by scores from high (3 points) to medium (2 points) and low (1 point). The student could score a maximum of up to 30 points in one lesson.

For the first 5 lessons, students in total scored from 75 to 120 points each. According to their scores, the students were conveniently classified into 5 groups: 70-80 points – "nihilists" (2 students, 8%), 81-90 points – "unbelievers" (8 students, 32%), 91-100 points – "potential well-wishers" (8 students, 32%), 101-110 points – "well-wishers" (3 students, 12%) and 111-120 points – "fan" (4 students, 12%). The assessment of the statistical significance of differences in the total sample of students was carried out according to the paired Wilcoxon T-test. Since T value ( $T(0) < p(0.01)$ ) is within significance level, the results obtained at the end of the experiment are significantly higher than the initial results.

As subjectively observed, the "nihilists" try not to stand out in the group, rarely engage into discussion, do not tend to think critically, though succeeding in written assignments each lesson. They consider nature as a means to achieve their goals. The

"unbelievers" are more prone to non-pragmatic interactions with nature, but there are many pragmatists among them, while action component is not developed. The "potential well-wishers" each lesson strive to join the group of "well-wishers", though being passive in the lessons. Their cognitive component is not developed. In the "well-wishers" the most developed component of attitude towards nature is the perceptual/affective one, with the cognitive one - on the second, and the activity or practical - on the third place. In the "fans", the action component prevails, assisted mainly by practical and perceptual/affective components. This group is characterized by critical thinking, comprehension and reflection on a given problem. The groups such as "nihilists", "unbelievers", and "potential well-wishers", and "well-wishers + fans" speak to the fact that the suggested and employed Botanical garden-based course of classes has a positive effect on the formation of environmental conscience and environmental culture among students. "Fans" who has grown as leaders over the project, have strong motivation for environmental protection, while "unbelieves" and "potential well-wishers" lesson by lesson have been raising their environmental awareness and have shown willingness and ability to solve environmental problems.

#### 4. FINDINGS

The obtained results show that the average value of the level of subjective attitude towards nature among students of the two sample groups generally corresponds to the average adolescent values determined by Russian scientists V.A. Yasvin, T.A. Zershchikova and M.V. Butakova. The students of both colleges has demonstrated the following environmental culture components levels: 38.2% – very high, 13.1% – high, 15.8% – above average, and 32.9% – average level, which is slightly higher than those obtained by Butakova M.V. in 2018 for the first year biology students of the Faculty of Natural Geography of the Vologda State University (very high – 3%, high – 47%, above average – 37%, average – 13%). Students in two samples demonstrated a substantial difference between the values of the very high level of components: 64% in SPCPU Pharmaceutical College, while only 25.5% in Murmansk Medical College.

The obtained data on the proportion of attitudinal components towards nature in SPCPU Pharmaceutical College students indicate the dominance of 100% perceptual/affective (100%) with practical (84%) scale, and perceptual/affective (100%) with action (84%) scale. This coincides to the

data that at 17-21 years for boys and 16-20 years of age for girls, as well as at 13-15 years of age, the attitude towards nature is continued to be dominated by the perceptual/affective component, which significantly exceeds all other components and reaches its ontogenetic maximum; the second predominant component is the practical one, and the third – is the action one. The cognitive component which predominates at the earlier ontogenetic stages becomes the least important (Yasvin, 2000). The data on Murmansk Medical College students indicate the predominance of the perceptual/affective scale (90.2%) and the naturalistic erudition scale (72.6%). There is also a link between the perceptual/affective and action scale (68.7%). The predominance of the perceptual/affective component may reflect the importance of the emotional component, despite the gradual loss of the cognitive component importance. This may be a reflection of the insufficient maturity of the practical and action components and the students' unwillingness to environmental activities. A strong positive correlation was found ( $R=0.73849$ ,  $p<0.001$ ) between the cognitive and practical scales. The other scale indicators have a weak ( $<0.5$ ), although traceable correlation. Among them, the strongest correlation is found between naturalistic erudition and high scores on the cognitive scale.

Data on the dominance of the perceptual/affective scale prove the aesthetic nature of environmental attitudes. The aesthetic element

spikes by the age of 16-17 and reaches its ontogenetic maximum. The ratio of the attitudinal intensity components towards nature, breadth and character of their dominance generally correspond to age patterns (Deryabo & Yasvin, 1996; Yasvin, 2000).

The proposed system of the Botanical Garden-based classes and application of case method demonstrate the effectiveness of pedagogic work in environmental education. The system of classes had a positive effect on shaping ecocentric personality attitude of pharmaceutical students, on raising the level of environmental culture. So, only one student assessed his level of environmental culture as "high" before the start of the project, and by the end of the project, four people were included by the researchers in the group of "fans", i.e. the students with a high level of environmental culture.

## 5. CONCLUSION

We believe that case method application and simultaneous updating of the environmental educational objectives in teaching allows increasing the level of pharmaceutical students' environmental culture and changing their attitudes toward nature. Such pedagogic work is important both for the students' future professional occupation, their successful self-actualization, and for a society striving to save the planet.

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## REFERENCES

- Alsharif, N. (2012). Globalization of Pharmacy Education: What is Needed? *American journal of pharmaceutical education*, 76, 77. <https://doi.org/10.5688/ajpe76577>
- Arystanova T.A., Ordabaeva S.K., Sopbekova A.O., Makhova E.G., Karakulova A.Sh. (2010) Keis – metod v podgotovke spetsialistov farmatsevtov [Case method for training pharmacy specialists]. *Vestnik KazNMU*, 4, 65-69 [in Russian]
- Asafova E.V. (2003) Vospitanie i diagnostika razvitiya ekologicheskoy kultury studentov /Prioritetnye strategii monitoringa kachestva vospitaniya studentov [Education and diagnostics of the development of ecological culture of students /Priority strategies for monitoring the quality of education of students] (V.I. Andreeva, Ed.) Kazan: izd-vo "Centr innovac. tekhnologiy" [in Russian]
- Asafova, E. V. (2011). Pedagogicheskie strategii razvitiya ekologicheskoi kultury studentov v klassicheskom universitete [Pedagogical strategies for the development of ecological culture of students at a classical university]. *Scientific notes of Kazan University. Humanities Series*, 153(5), 128–135 [in Russian]
- Biodiversity strategy for 2030 Retrieved from [https://ec.europa.eu/environment/strategy/biodiversity-strategy-2030\\_en](https://ec.europa.eu/environment/strategy/biodiversity-strategy-2030_en)
- Bokii, G. V. (2017). Interaktivnye metody obucheniya prepodavaniya botaniki u studentov – provizorov [Interactive teaching methods of teaching Botany for pharmacy students]. *Dostizheniya nauki i obrazovaniya*, 2 (15), 40–43 [in Russian]
- Borsch, T., & Löhne, C. (2014). Botanic gardens for the future: Integrating research, conservation, environmental

- education and public recreation. *Ethiopian Journal of Biological Sciences*, 13, 115–133
- Butakova, M. V. (2018). Formirovanie ekologicheskoi kompetentnosti v protsesse podgotovki studentov-biologov [Formation of environmental competence in the process of training biology students] *Materialy IV mezhdunarodnoi nauchno-prakticheskoi konferentsii «Biologicheskoe i ekologicheskoe obrazovanie studentov i shkolnikov: aktualnye problemy i puti ikh resheniya»*, 252–256 [in Russian]
- Burtseva, T. V. (2009). Formirovanie ekologicheskoi kompetentnosti budushchego farmatsevt na osnove integratsii estestvennonauchnykh distsiplin [Formation of the ecological competence of the future pharmacists based on the integration of natural science disciplines]. Extended abstract of candidate's thesis. Yekaterinburg [in Russian]
- Briggs, L., Trautmann, N., & Phillips, T. (2019). Exploring challenges and lessons learned in cross-cultural environmental education research. *Evaluation and Program Planning*, 73, 156–162. <https://doi.org/10.1016/j.evalprogplan.2019.01.001>
- BGCI Technical Review «The role of botanic gardens in practising and promoting environmental sustainability», April 2020 Published by Botanic Gardens Conservation International Descanso House, 199 Kew Road, Richmond, Surrey, TW9 3BW, U.K <https://www.bgci.org/wp/wp-content/uploads/2020/04/ReviewMedRes.pdf>
- Chen, G., & Weibang, S. (2018). The role of botanical gardens in scientific research, conservation, and citizen science. *Plant Diversity*. Vol. 40, Issue (04): 181–188. <https://doi.org/10.1016/j.pld.2018.07.006>
- Cheng, J., & Monroe, M. (2012). Connection to Nature: Children's Affective Attitude Toward Nature. *Environment and Behavior – ENVIRON BEHAV*, 44, 31–49. <https://doi.org/10.1177/0013916510385082>
- Deryabo, S. D. & Yasvin V. A. (1996) *Ekologicheskaya pedagogika i psikhologiya*. [Environmental pedagogy and psychology]. Rostov-na-Donu [in Russian]
- Deryabo, S. D. (1999). *Ekologicheskaya psikhologiya: Diagnostika ekologicheskogo soznaniya: uchebnoe posobie* [Ecological psychology: Diagnostics of ecological consciousness]. Akad. ped. i sots. nauk, Mosk. psikhol.-sots. in-t. [in Russian]
- Devkota, H., & Watanabe, M. (2020). Role of medicinal plant gardens in pharmaceutical science education and research: An overview of medicinal plant garden at Kumamoto University, Japan. *Journal of Asian Association of Schools of Pharmacy*, 9, 44–52
- Dezhnikova N.S., Ivanova L.Yu. (2014) *Vospitanie ekologicheskoi kultury detei i podrostkov* [Education of ecological culture in children and adolescents] Moscow: Pedagogicheskoe obshchestvo Rossii [in Russian]
- Etkin, N. L. (1988). Ethnopharmacology: Biobehavioral Approaches in the Anthropological Study of Indigenous Medicines. *Annual Review of Anthropology*, 17, 23–42. <https://doi.org/10.1146/annurev.an.17.100188.000323>
- He, H., & Chen, J. (2012). Educational and enjoyment benefits of visitor education centers at botanical gardens. *Biological Conservation*, 149, 103–112. <https://doi.org/10.1016/j.biocon.2012.01.048>
- Herndl C.G., Brown S.S. (eds.) (1996) *Green Culture: environmental rhetoric in contemporary America*. – Madison: Univ. of Wisconsin Press.
- Ischenko, A. V., Sovetova, M. P., & Mitina, E. G. (2020). Readiness of Russian Botanic Gardens potential visitors to participate in educational interaction. *Science for Education Today*, 10 (5), 161–177. <http://dx.doi.org/10.15293/2658-6762.2005.09>
- Jeronen, E., Palmberg, I., & Yli-Panula, E. (2016). Teaching Methods in Biology Education and Sustainability Education Including Outdoor Education for Promoting Sustainability – A Literature Review. *Education Sciences*, 7, 1–19. <https://doi.org/10.3390/educsci7010001>
- Jovanovic, S., Gatarić, D., Prnjat, Z., Andjelković, G., Jovanović, J., Lukić, B., & Lutovac, M. (2016). Exploring Proenvironmental Behavior of Serbian Youth Through Environmental Values, Satisfaction, and Responsibility. *Social Behavior and Personality: an international journal*, 44, 1057–1068. <https://doi.org/10.2224/sbp.2016.44.7.1057>
- Kalugin, Y., & Musinova, L. (2021). Night of Museums in Peter the Great Botanical Garden. *European Proceedings of Social and Behavioural Sciences EpSBS*, 11, 2628–2638.
- Kalugin, Yu. G., & Musinova, L. P. (2017). Postoyannye i vremennye ekspozitsii sukkulentov Botanicheskogo sada Petra Velikogo kak sredstvo biologicheskogo i ekologicheskogo prosveshcheniya [Permanent and temporary display of succulents in the Botanical Garden of Peter the Great as a means of biological and

- ecological education]. *Samarskii nauchnyi vestnik*, 6 (4 (21)), 222–227 [in Russian]
- Kashlev, S. S. (2012). *Pedagogicheskaya diagnostika v protsesse ekologicheskogo obrazovaniya: Sushchnost i metodika provedeniya* [Pedagogical diagnostics in the process of environmental education: The essence and methodology of conducting]. *Vestnik MGGU im. M.A. Sholokhova. Sotsialno-ekologicheskie tekhnologii*, 2, 126–134 [in Russian]
- Kolossova, I., Marhon N., Mayor V., Shatornaya V. (2018) Modern approaches to optimization of educational process in the Medical Biology, Pharmacognosy And Botany Department of the State Institution “Dnipropetrovsk Medical Academy of Health Ministry of Ukraine. *Modern Science – Moderní věda*, 5, 94–103.
- Kümmerer, K. (2010). *Pharmaceuticals in the Environment*. *Annual Review of Environment and Resources*, 35, 57–75. <https://doi.org/10.1146/annurev-environ-052809-161223>
- Mdivani M.O., Lidskaya E.V., Khisambeev Sh.R., Panov V.I. (2010) *Metodika eksperimentalnogo issledovaniya ekologicheskogo soznaniya: razrabotka i aprobatsiya* [Methodology of experimental research of ecological consciousness: development and approbation]. *Rossiiskii nauchnyi zhurnal*, 1 (14), 64–78 [in Russian]
- Mounce, R., Smith, P., & Brockington, S. (2017). *Ex situ conservation of plant diversity in the world’s botanic gardens*. *Nature Plants*, 3, 795–802. <https://doi.org/10.1038/s41477-017-0019-3>
- Nartova-Bochaver, S., & Mukhortova, E. (2019). *Oprosnik «Lyudi i rasteniya»: otnoshenie cheloveka k miru rastenii* [Questionnaire “People and plants” (pap): a study of human attitude towards the plants]. *Psikhologicheskii zhurnal* [Psychological Journal], 41, 86–96 [in Russian] <https://doi.org/10.31857/S020595920007984-8>
- Nisbet, E. K., Zelenski, J. M., & Murphy, S. A. (2009). *The Nature Relatedness Scale: Linking Individuals’ Connection With Nature to Environmental Concern and Behavior*. *Environment and Behavior*, 41(5), 715–740. <https://doi.org/10.1177/0013916508318748>
- Ofstad, W., & Brunner, L. (2013). *Team-Based Learning in Pharmacy Education*. *American journal of pharmaceutical education*, 77(4), 70. <https://doi.org/10.5688/ajpe77470>
- Petukhova, M. A., & Krivoshepkina, O. M. (2019). *Sravnitelnyi analiz diagnostiki opyta emotsionalno-tsennostnykh otnoshenii k prirode studentov-estestvennikov* [Comparative analysis of the diagnostics of natural students’ experience of emotional/value relationships towards] *Sovremennye problemy nauki i obrazovaniya*, 6, 16. [in Russian] <https://doi.org/10.17513/spno.29293>
- Silviariza, W., Sumarmi, S., & Handoyo, B. (2021). *Improving Critical Thinking Skills of Geography Students with Spatial Problem Based Learning (SPBL)*. *International Journal of Instruction*, 14, 133–152. <https://doi.org/10.29333/iji.2021.1438a>
- Sharypova N.V. & Pavlova N.V. (2018) *Kvest i keis kak elementy interaktivnykh tekhnologii v sovremennom biologicheskom obrazovanii* [Quest and case as elements of interactive technologies in modern biological education] *Samarskii nauchnyi vestnik*, 7, 1(22), 297–301[in Russian]
- Sutiani, A., Situmorang, M., & Silalahi, A. (2021). *Implementation of an Inquiry Learning Model with Science Literacy to Improve Student Critical Thinking Skills*. *International Journal of Instruction*, 14, 117–138. <https://doi.org/10.29333/iji.2021.1428a>
- Tampoukou, A., Papafotiou, M., Koutsouris, A., & Paraskevopoulou, A. (2015). *Teachers’ Perceptions on the Use of Botanic Gardens as a Means of Environmental Education in Schools and the Enhancement of School Student Benefits from Botanic Garden Visits*. *Landscape Research*, 40, 5, 610–620. <https://doi.org/10.1080/01426397.2014.947250>
- The Convention on Biological Diversity (CBD) Retrieved from <https://www.cbd.int/>
- Tkachenko, K. (2019). *On creating specialized botanical gardens of traditional Chinese medicinal plants*. *Hortus botanicus*, 14 [in Russian]
- Tseng, Y.-C., Sakurai, R., & To, K. (2021). *Comparing Undergraduates’ Connection with Nature and New Ecological Paradigm in Relation to Intention of Environmental Behaviors in Taiwan and Japan*. *Japanese Journal of Environmental Education*, 31, 2, 38–50. [https://doi.org/10.5647/jsoee.31.2\\_38](https://doi.org/10.5647/jsoee.31.2_38)
- Tsitsilin, A.N. (2016) *Educational and industrial practices of universities and colleges students in the Botanical garden of medicinal plants of VILAR (current trends and challenges)*. *Botanical Gardens in the Modern World: Science, Education, and Management*, 77–80.
- Umnova-Konyukhova, I. A., Vakula, M. A., & Aleshkova, I. (2021). *Ecological culture: Sociocultural and legal aspects*. *SHS Web of Conferences*, 118, 02007. <https://doi.org/10.1051/shsconf/202111802007>

- Yasvin, V.A. (2000) *Psikhologiya otnosheniya k prirode* [Psychology of the attitude towards nature]. Moscow: SMYSL [in Russian]
- Zershchikova, T.A. (2018) *Ekologicheskaya kultura studentov meditsinskogo kolledzha i ee razvitie v obrazovatelnom protsesse* [Environmental culture of medical college students and its development in the educational process]. *Scientific review*, № 1, 28-32 [in Russian].