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СТАТИСТИЧНИЙ АНАЛІЗ РЕЗУЛЬТАТІВ МОНІТОРИНГУ ПЕРЕДУМОВ
ВПРОВАДЖЕННЯ ПРОЕКТУ EcoBRU

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STATISTICAL ANALYSIS OF MONITORING RESULTS
OF PREREQUISITES FOR EcoBRU PROJECT IMPLEMENTATION

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ПРЕДПОСЫЛОК ВНЕДРЕНИЯ ПРОЕКТА EcoBRU

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Formulation of the problem. International cooperation is an integral part of the activity of National Transport University (NTU) and an important tool in ensuring the quality of education and its compliance with international standards. One of the priorities for the development of international activity of the university is its fruitful cooperation with European universities, research institutions and organizations within the framework of TEMPUS international educational projects. Nowadays, NTU is the national coordinator of three TEMPUS projects, namely "Ecological Education for Belarus, Russia and Ukraine (EcoBRU)", "Centres of Excellence for young RESearches (CERES)", and "Fostering the Knowledge Triangle in Belarus, Ukraine and Moldova (FKTBUM)".

An important prerequisite for EcoBRU project implementation is the analysis of project participants' level of knowledge, values and expectations, which will smooth out the difference between the indicators for education quality improvement in the field of environmental education at all levels of the educational system. To do this, it is necessary to collect the required information and to process it statistically with the aim of presenting data in a form suitable for analysis. Carrying out such analysis aims at identifying certain patterns in the process of knowledge management of project participants [1].

The aim is to carry out the statistical analysis of monitoring results of prerequisites for EcoBRU project implementation. To achieve this aim the following tasks have been set:

- to analyse the peculiarities and aims of EcoBRU project;
- to characterize the participants of EcoBRU project;
- to justify the choice of method for obtaining statistical information and to investigate project participants' level of knowledge, values and expectations;
- to carry out the statistical analysis of monitoring results of prerequisites for EcoBRU project implementation and to identify areas of implementation of continuous environmental education of university lecturers of different levels of accreditation and school teachers in Ukraine.

The basic material. Project 543707-TEMPUS-1-2013-1-DE-TEMPUS-JPHES "Ecological Education for Belarus, Russia and Ukraine (EcoBRU)" is a logical continuation of the previous project "Environmental Management for Russia and Ukraine (UMRU)" and it is the intensification of international collaboration of scientists and university lecturers in the field of nature conservation. The project contributes to the continuous training of Belarusian, Russian and Ukrainian teachers of vocational schools and colleges and school teachers. E-learning programme – training courses in environmental education – is being developed and implemented for this target group. The intention of Belarusian, Russian and Ukrainian governments to improve and enhance the environmental education at all levels of the educational system is therefore supported.

The main aims of the project are:

- to develop training programs on environmental education for teachers in the context of multi-level educational system in Belarus, Russia and Ukraine;
- to test, implement, officially recognize and use in future distance learning courses in environmental education of teachers in the context of multi-level educational system;
- to implement and modernize environmentally oriented curricula.

To achieve the aims of the project the consortium includes partners with different expertise and experience in implementing vocational education programmes, in implementing TEMPUS projects or experience in joint project activity. Project coordination is carried out by the University of Bremen (Bremen, Germany). The implementation is carried out by universities of partner countries from Gomel, Minsk and Vitebsk in Belarus; Lipetsk, Magnitogorsk, Novgorod, Novosibirsk, Rostov-on-Don and St. Petersburg in Russia; Kyiv, Simferopol, Sevastopol, Chernivtsi and Pereyaslav-Khmelnytskiy in Ukraine. The support, in turn, is provided by university and non-university European partners from Germany, Latvia, Slovakia and the Czech Republic. The analysis of project participants showed that each of them deals with environmental problems in different areas: industrial technologies and processes, infrastructure and spatial planning, transport, economics, etc.

Prerequisites for the project implementation envisage coordination towards the development of training materials and training courses for different target groups. To determine the level of knowledge, values and expectations of project participants and to identify the differences between the indicators of education quality improvement in the field of ecology at all levels of the educational system and reliability assessment of these differences, statistical research of project participants is conducted. Statistical research plan includes the following steps:

1) the formulation of research objectives and determining the desired sample size (the aim, objects of the study, their number, what features are taken into account, what object characteristics are evaluated);

2) the collection of relevant data, the choice of reasonable form of data submission for further study, their visual representation after partial processing;

3) conducting final processing of statistical data and their study.

It results in definite conclusions. Usually the objects are examined according to their specific characteristics. Thus, to identify the differences between the indicators of education quality improvement in the field of ecology at all levels of the educational system, the following features were established - environmental behavior, environmental education, knowledge of environmental laws and regulations of environmental management, environmental economics, professional training.

The object of the study is National Transport University lecturers and teachers of Kyiv Transport and Economic College (29.7%), NTU 1st, 3rd, 5th-year students majoring in "Ecology and Environmental Protection" (59.4%), NTU third-year students majoring in "Vocational Education Teaching" (10.9%). The total sample size is 101 persons. The following parameters were taken into account: the area of study, the current level of environmental knowledge, the period of study, age and gender of the participants. The necessity to obtain additional knowledge about the environment and the area of this knowledge are assessed as the characteristics of the objects.

To collect the necessary data a questionnaire as a method of research was proposed. The popularity of this method is explained by the variety and quality of sociological information that can be obtained. This method is based on the statements of individuals and is conducted to identify subtle nuances of respondents' opinions. The survey results will be used by project partners to develop the ways of improving training programmes of various educational disciplines in order to raise environmental awareness [2].

For different types of participants there were developed three types of questionnaires which reflected the status of the participant, i.e. "lecturer", "teacher", "student". Here is the general idea of developed questionnaires. The proposed questionnaires included three blocks. The questionnaire began with a preamble addressing the respondent. It stated who conducts the research, the purpose of the research, the nature of the use of the results, the anonymous nature of the questionnaire, a way of filling the questionnaire and the gratitude for participating in the survey. Next comes the main part of the questionnaire which contains blocks of questions to the respondents, and the third part, demographic questions, which provides information about the respondents (gender, age, education, place of residence, social status, etc.). The main part of the questionnaire contains 73 questions that are divided into groups: questions that reveal the knowledge of environmental problems - 15 questions (20.5%), determine the level of general environmental education - 5 questions (6.8%), characterize the environmental behavior of the respondent - 12 questions (16.4%), show the knowledge of environmental laws and rules of nature use - 9 questions (12.3%), the knowledge of

environmental economics - 2 questions (2.7%) and questions that reflect the professional training of the participant - 30 questions (41.1%).

Surveying each respondent lasted no more than 30-40 minutes.

More complicated questions are placed after easier ones. The first question is neutral - neither debatable nor sensitive. Difficult questions are placed in the middle of the questionnaire so that the respondent " is involved" in the subject. The questions are clear and easy to understand to all respondents and they meet the logical requirements: first, it is the establishment of a fact, event and then its assessment [3,4].

According to the content the questions of the questionnaire were divided into:

• questions about the facts by which information about the environmental effects, about disciplines studied by the respondents, and professional training in ecology, etc. is obtained;

• questions about the knowledge of specific environmental aspects (legislation or environmental economics), the purpose of which is to find out what the respondent knows and what he can tell. Normally these are the questions which have the purpose to identify the level of awareness of the respondent and his knowledge in the field of environmental protection;

• questions about respondent's opinion on environmental education, they are intended to fix the facts, wishes, expectations, future plans and they deal with any problems and the personality of the respondent;

• questions about the motives of environmental activities.

By their logical nature the questions included:

• basic questions, the answers to which is the basis for making conclusions about the phenomena studied;

• screener questions - are asked to weed out incompetent persons in the survey of environmental education problems;

• benchmarking questions to test stability, consistency and truthfulness of responses, to determine their validity;

• questions that suggest, assist the respondent in correct understanding of the basic question, in finding the exact answer.

The fragment of the developed questionnaire for students of vocational and higher education institutions is presented on Fig. 1.

Figure 1 – The fragment of the questionnaire for students of vocational and higher education institutions

After gathering the necessary information, its structuring involves the identification of parameters and objects where they should be measured, as well as indicators that should be fixed for this. The formalization usually involves the procedures of sampling, access to information and its fixation and measuring procedures. Structured and formalized information is research data, and the process of formalization is collection of data. Typically, statistical programmes serve as a matrix of "object-feature" type. In data matrix each row is given one object (1, 2, .., n), and each column is given one feature of the variable ($X_1, X_2,..., X_к$). At the intersection of i-row and j-column there is value x_{ij} – j-feature for object with number i [5,6].

Table 1 shows the results of the survey data according to indicators of education quality improvement for all target groups of respondents, expressed in %.

Table 1 – The results of the survey data according to indicators of education quality improvement for all target groups of respondents (%)

Indicators of education quality improvement	Agree	Partly agree	More disagree than agree	Disagree
Environmental education (secondary), X_1	72,73	19,09	6,36	1,82
Environmental education (higher), X_2	63,64	28,93	6,61	0,83
Environmental behaviour , X_3	38,70	46,74	11,88	2,68
The knowledge of environmental laws and rules of nature use, X_4	46,91	34,78	14,87	3,43
Environmental economics, X_5	59,09	36,36	4,55	0,00
The professional training of the lecturers, X_6	49,44	40,09	9,13	1,34

The results of data analysis of table 1 indicate a high level of respondents' agreement on the necessity of training in environmental education for teachers and lecturers in the context of multi-level educational system according to all indicators of education quality improvement. It is especially typical for secondary education (the level of agreement is 72.73%). The relatively high values of variant "partly agree" according to the indicators of education quality improvement X_3 - X_6 indicate a lack of respondents' awareness on these issues.

The example of survey results for the indicator "environmental behaviour" for lecturers and students majoring in "Ecology and Environmental Protection (EEP)" is shown on Fig. 2. Fig. 3 shows the example of survey results for the indicator "environmental behaviour" for students majoring in "Vocational Education Teaching (VET)".

a) lecturers

b) students majoring in "Ecology and Environmental Protection"
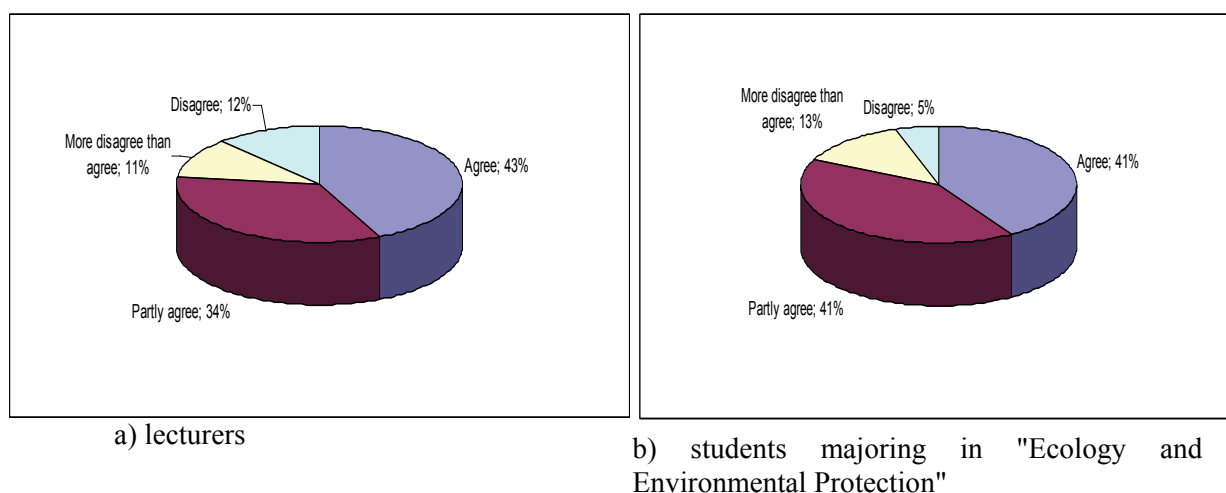
Figure 2 – Survey results of target groups for the indicator "environmental behaviour"
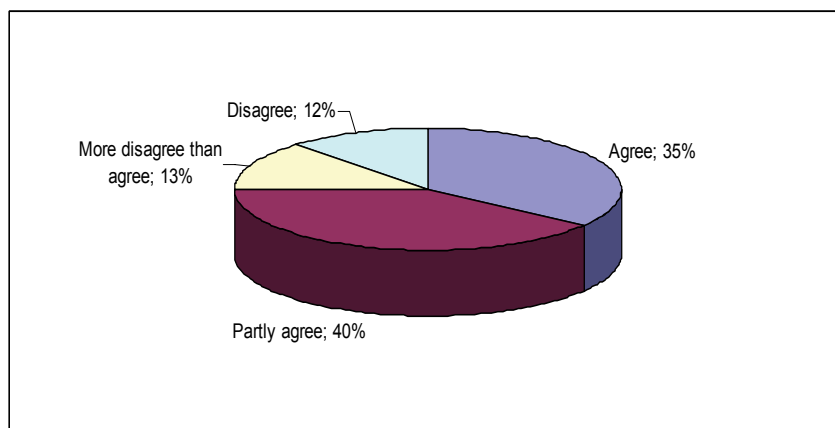

Figure 3 – Survey results for the indicator "environmental behaviour" for students majoring in "Vocational Education Teaching"

The analysis of the survey results in terms of "environmental behaviour" shows that both lecturers and students majoring in "Ecology and Environmental Protection (EEP)" agree with the necessity to form environmental behaviour and public consciousness (43% and 41% respectively). But the number of answers "disagree" (12% and 5% respectively) implies that lecturers assess the situation more real, while the students majoring in "Ecology and Environmental Protection" because of their age and lack of experience have rather an idealized idea. The analysis of the survey results of students majoring in "Vocational Education Teaching (VET)" (Pic. 3) shows that the environmental consciousness of respondents has not been sufficiently developed yet or they just lack special knowledge of ecology, stressing the number of answers "partly agree" (40%).

For each indicator of education quality improvement the frequency of variants (m) - agree; partly agree; more disagree than agree and disagree - for each target group (assessment object) and the relative frequency of the variants ($\frac{m}{n}$) were rated. The results of the relative frequency of variants for the indicator "environmental behaviour" are presented in Table 2.

The sum of the relative frequencies of the sample is 1.

Table 2 – The results of the relative frequency of variants for the indicator "environmental behaviour"

Target group	NTU lecturers	College teachers	Students of VET I	Students of EEP I	Students of EEP III	Students of EEP V
Variant "agree"						
Counting, m	85	70	44	90	101	105
Frequency, $\frac{m}{n}$	0,17	0,14	0,09	0,18	0,20	0,21
Variant "partly agree"						
Counting, m	60	60	48	84	122	86
Frequency, $\frac{m}{n}$	0,13	0,13	0,10	0,18	0,26	0,19

For the data presented in Table 2 root-mean-square deviation and variance of the survey results were determined. The difference between any dimension of the sample x and the arithmetic mean of this sample is referred to as a deviation of variant x_i from $\bar{X}$: $x - \bar{X}$.

For the indicator "environmental behaviour" the arithmetic mean of the variant "agree" is 90.2. To find root-mean-square deviation of existing data of parent population the following formula is used:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{X})^2}{n}}, \tag{1}$$

where x_i is the value of i-variant, i=1,...,n, $\bar{X}$ is arithmetic mean, n is parent population. Root-mean-square deviation σ= 0,395. Since the biased variance $D(X) = \sigma^2$, then $D(X)$ =0,156.

Describing a whole population by its part only, it is impossible to avoid errors called non-sampling errors. Even in ideal survey work there are errors of this type. Non-sampling error of the arithmetic mean depends on two variables: the variety of features in parent population and the size of the sample. The lower the variety (root-mean-square deviation indicates its value) and the greater the number of objects selected for the research the lower the value of non-sampling error of sample arithmetic mean.

To calculate this, the following formula is used:

$$\Delta = \frac{\sigma}{\sqrt{n}} \tag{2}$$

The value of non-sampling error is $\Delta = \frac{0,395}{\sqrt{5}} \approx 0,176$.

The reliability of differences between groups of individual indicators can be determined by Fisher criterion using the following formula:

$$F = \frac{(\bar{X_1}-\bar{X_2})^2}{\sigma_B^2} \cdot \frac{n_1 \cdot n_2}{n_1 + n_2} \geq F_{st}\left\{ \begin{matrix} v_1=1 \\ v_2=n_1+n_2 \end{matrix} \right\}, \tag{3}$$

where F is Fisher criterion, $\bar{X_1}$ and $\bar{X_2}$ are arithmetic means;
σ_B is random variant calculated by the following formula:

$$\sigma_{\tilde{\sigma}}^2 = \frac{n_1 \cdot (n_1 - 1) \cdot \Delta_1^2}{n_1 + n_2 - 2}, \qquad (4)$$

where n_1, n_2 are the number of dimensions in groups.

Calculated Fisher criterion is compared with the standard Fisher criterion for three values of the reliability level of 0.95, 0.99 and 0.999 [7,8].

Let us calculate the reliability of difference between the groups of indicators of environmental education for secondary and higher education institutions for variant "agree". Group sampling for both variants is presented in Table 3.

Table 3 – The results of appearance of variant "agree" of the indicator "environmental education" for all target groups

Target group	NTU lecturers	College teachers	Students of VET I	Students of EEP I	Students of EEP III	Students of EEP V
The indicator of secondary environmental education						
Counting, m	54	55	69	60	80	64
The indicator of higher environmental education						
Counting, m	111	92	49	118	154	132

For the indicator "environmental education (secondary)" the arithmetic mean of the variant "agree" is 63.7. The value of root-mean-square deviation calculated by the formula (1) is σ= 1,118. The value of non-sampling error is $\Delta = \frac{1,118}{\sqrt{5}} \approx 0,498$.

The value of random variant is: $\sigma_1^2 = \frac{6 \cdot 5 \cdot 0,498^2}{5 + 6 - 2} = 0,896$.

For the indicator "environmental education (higher)" the arithmetic mean of the variant "agree" is 109,33. The value of root-mean-square deviation calculated by the formula (1) is σ= 3,15. The value of non-sampling error is $\Delta = \frac{3,15}{\sqrt{5}} \approx 1,408$. The value of random variant is: $\sigma_1^2 = \frac{6 \cdot 5 \cdot 1,408^2}{5 + 6 - 2} = 6,608$.

Then the value of Fisher criterion can be calculated by the formula (3). Calculated criterion is:

$$F = \frac{(109,33 - 63,7)^2}{0,896} \cdot \frac{6 \cdot 5}{6 + 5} = 138,89.$$

Standard value of Fisher criterion is 19,7.

So, $F \geq F_{st\left\{ \begin{smallmatrix} v_1 = 1 \\ v_2 = n_1 + n_2 \end{smallmatrix} \right\}}$, which indicates the reliability of differences between the groups of indicators of secondary and higher environmental education.

A statistical analysis of the survey of target groups of EcoBRU project identified common elements in corresponding indicators of education quality improvement in the field of ecology at all levels of the educational system. It allowed to choose the subject area of training programmes on environmental education for teachers and lecturers in the context of multi-level educational system in Belarus, Russia and Ukraine. To implement the project in Ukraine there were offered 5 areas: organizational and methodological basis for the creation of environmental culture (4.1%), environmental management (4.3%), information technology (4.7%), pedagogy (6.7%), environmental safety and environmental protection (9.4%) (Fig. 4).
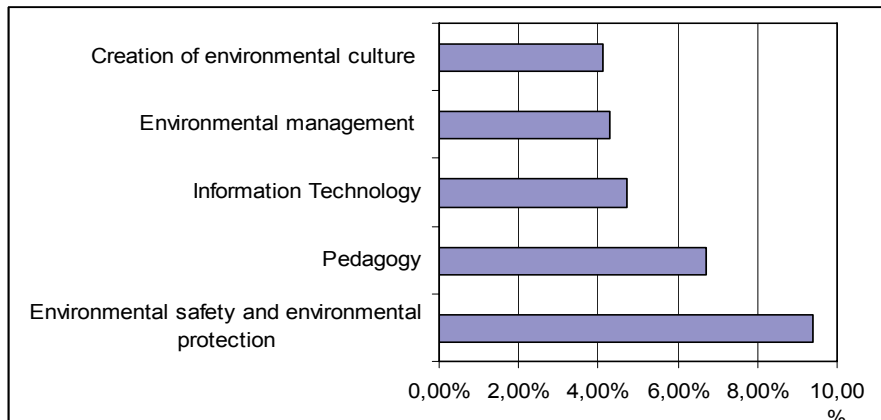

Figure 4 – Subject area of e-learning courses

Conclusions. Thus, the analysis of peculiarities, aims and participants of EcoBRU project allowed to explore their level of knowledge, values and expectations. The collected information enabled to carry out the statistical analysis of monitoring results of prerequisites for EcoBRU project implementation. A statistical analysis of the survey results of project target groups identified the areas of implementation of continuous environmental education of university lecturers of different levels of accreditation and school teachers in Ukraine.

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РЕФЕРАТ

Матейчик В.П. Статистичний аналіз результатів моніторингу передумов впровадження проекту EcoBRU / В.П. Матейчик, В.О. Хрутьба, Н.М. Горідько // Вісник Національного транспортного університету. Серія «Технічні науки». Науково-технічний збірник. – К. : НТУ, 2015. – Вип. 1 (31).

У статті представлений аналіз рівня знань, цінностей та очікувань учасників проекту EcoBRU програми TEMPUS. Проект сприяє безперервному навчанню у сфері екології на усіх рівнях освітньої системи. При реалізації проектів ТЕМПУС зазвичай не враховуються закономірності управління знаннями учасників проекту. Зібрана інформація та її статистична обробка спрямовані на визначення напрямків впровадження в Україні безперервного екологічного навчання викладачів ВНЗ різних рівнів акредитації та вчителів загальноосвітніх шкіл.

Метою роботи є статистичний аналіз результатів моніторингу передумов впровадження проекту EcoBRU. Для досягнення цієї мети в роботі вирішуються наступні **завдання**:

• проаналізувати особливості та цілі проекту EcoBRU;

• охарактеризувати учасників проекту EcoBRU;

• обґрунтувати вибір методу одержання статистичної інформації та провести дослідження рівня знань, цінностей та очікувань учасників проекту;

• здійснити статистичну обробку результатів моніторингу передумов впровадження проекту EcoBRU та визначити напрямки впровадження в Україні безперервного екологічного навчання викладачів ВНЗ різних рівнів акредитації та вчителів загальноосвітніх шкіл.

Результати аналізу даних опитування дозволили визначити показники поліпшення якості навчання всіх цільових груп респондентів. Для кожного показника поліпшення якості навчання була оцінена частота появи варіанти згоден; частково згоден; більше не згоден, ніж згоден та не згоден для кожної цільової групи та відносна частота появи варіанти. За цими даними розраховане значення помилки репрезентативності. За критерієм Фішера вдалося встановити достовірності різниць між групами показників середньої та вищої екологічної освіти. Результати статистичного аналізу

анкетування цільових груп проекту EcoBRU виявили спільні елементи у відповідних показниках поліпшення якості навчання у сфері екології на усіх рівнях освітньої системи. Це дозволить партнерам проекту вибрати тематику програм підвищення кваліфікації з екологічної освіти для вчителів і викладачів у контексті багаторівневої системи освіти у Білорусі, Росії і Україні з метою формування екологічної свідомості.

КЛЮЧОВІ СЛОВА: ЕКОЛОГІЧНИЙ ПРОЕКТ, СТАТИСТИЧНИЙ АНАЛІЗ, БЕЗПЕРЕРВНА ЕКОЛОГІЧНА ОСВІТА, ПОКАЗНИКИ ПОЛІПШЕННЯ ЯКОСТІ НАВЧАННЯ.

ABSTRACT

Mateichyk V., Khrutba V., Horid'ko N. Statistical analysis of monitoring results of prerequisites for EcoBRU project implementation. Visnyk National Transport University. Series «Technical sciences». Scientific and Technical Collection. – Kyiv: National Transport University, 2015. – Issue 1 (31).

The paper analyzes the level of knowledge, values and expectations of EcoBRU project participants of TEMPUS programme. The project promotes lifelong learning in ecology at all levels of the educational system. Certain patterns in the process of knowledge management of project participants are usually not taken into account when implementing TEMPUS projects. The information collected and its statistical analysis are aimed at identifying the areas of implementation of continuous environmental education of university lecturers of different levels of accreditation and school teachers in Ukraine.

The aim is to carry out the statistical analysis of monitoring results of prerequisites for EcoBRU project implementation. To achieve this aim the following **tasks** have been set:

- to analyse the peculiarities and aims of EcoBRU project;
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- to justify the choice of method for obtaining statistical information and to investigate project participants' level of knowledge, values and expectations;
- to carry out the statistical analysis of monitoring results of prerequisites for EcoBRU project implementation and to identify areas of implementation of continuous environmental education of university lecturers of different levels of accreditation and school teachers in Ukraine.

The results of the survey data allowed to identify the indicators of education quality improvement for all target groups of respondents. For each indicator of education quality improvement the frequency of variants - agree; partly agree; more disagree than agree and disagree - for each target group and the relative frequency of the variants were rated. The value of non-sampling error was calculated using these data. Fisher criterion enabled to determine the reliability of differences between the groups of indicators of secondary and higher environmental education. A statistical analysis of the survey of target groups of EcoBRU project identified common elements in corresponding indicators of education quality improvement in the field of ecology at all levels of the educational system. This will allow the project partners to choose the subject area of training programmes on environmental education for teachers and lecturers in the context of multi-level educational system in Belarus, Russia and Ukraine in order to raise environmental awareness.

KEY WORDS: ENVIRONMENTAL PROJECT, STATISTICAL ANALYSIS, CONTINUOUS ENVIRONMENTAL EDUCATION, INDICATORS OF EDUCATION QUALITY IMPROVEMENT.

РЕФЕРАТ

Матейчик В.П. Статистический анализ результатов мониторинга предпосылок внедрения проекта EcoBRU / В.П. Матейчик, В.А. Хрутьба, Н.М. Горидько // Вестник Национального транспортного университета. Серия «Технические науки». Научно-технический сборник. – К. : НТУ, 2015. – Вып. 1 (31).

В статье представлен анализ уровня знаний, ценностей и ожиданий участников проекта EcoBRU программы TEMPUS. Проект способствует непрерывному обучению в сфере экологии на всех уровнях образовательной системы. При реализации проектов ТЕМПУС обычно не учитываются закономерности управления знаниями участников проекта. Собранная информация и ее статистическая обработка направлены на определение направлений внедрения в Украине непрерывного экологического обучения преподавателей вузов разных уровней аккредитации и учителей общеобразовательных школ.

Целью работы является статистический анализ результатов мониторинга предпосылок внедрения проектаEcoBRU. Для достижения этой цели в работе решаются следующие **задачи**:

• проанализировать особенности и цели проекта EcoBRU;
• охарактеризовать участников проекта EcoBRU;
• обосновать выбор метода получения статистической информации и провести исследование уровня знаний, ценностей и ожиданий участников проекта;

• выполнить статистическую обработку результатов мониторинга предпосылок внедрения проектаEcoBRU и определить направления внедрения в Украине непрерывного экологического обучения преподавателей вузов разных уровней аккредитации и учителей общеобразовательных школ.

Результаты анализа данных опроса позволили определить показатели улучшения качества обучения всех целевых групп респондентов. Для каждого показателя улучшения качества обучения была оценена частота появления варианты согласен; отчасти согласен; больше не согласен, чем согласен и не согласен для каждой целевой группы и относительная частота появления варианты. По этим данным рассчитано значение ошибки репрезентативности. По критерию Фишера удалось установить достоверности различий между группами показателей среднего и высшего экологического образования. Результаты статистического анализа анкетирования целевых групп проекта EcoBRU обнаружили общие элементы в соответствующих показателях улучшения качества обучения в области экологии на всех уровнях образовательной системы. Это позволит партнерам проекта выбрать тематику программ повышения квалификации по экологическому образованию для учителей и преподавателей в контексте многоуровневой системы образования в Беларуси, России и Украины с целью формирования экологического сознания.

КЛЮЧЕВЫЕ СЛОВА: ЭКОЛОГИЧЕСКИЙ ПРОЕКТ, СТАТИСТИЧЕСКИЙ АНАЛИЗ, НЕПРЕРЫВНОЕ ЭКОЛОГИЧЕСКОЕ ОБРАЗОВАНИЕ, ПОКАЗАТЕЛИ УЛУЧШЕНИЯ КАЧЕСТВА ОБУЧЕНИЯ.

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