Formation of project competence of future environmentalists

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Abstract. We have gained successful experience in conducting educational projects with students-environmentalists of various thematic areas. The topics of ecological projects was related to a practical, professionally oriented block of the curriculum and are intended to deepen the knowledge of individual students in a certain area in order to differentiate the learning process. Most often, project topics relate to a specific practical issue that is relevant to real life. At the same time, it requires the acquisition of students' knowledge from different subjects stimulates systematic creative thinking, turning up the research skills and opens opportunities for effective using of ICT in the project activity.

Introduction

Education is a priority tool for the sustainable progress of society, because the level of socio-economical amplification of society, in general, or of the state, is determined by the level of education and culture of its citizens. "Providing inclusive and equitable quality education and promoting learning opportunities during life for all" is one of the main indicators of a sustainable society progress [1]. The role of education for sustainable development is a major and urgent problem of scientific research, the vast majority of which is focused on the environmental component of education, for example, V. M. Bogolyubov [2], M. Klimenko [3], Y. Skyba [4]. In our opinion, higher ecological education is the most important factor in formation thinking focused on a sustainable harmonious future. The task of modern higher ecological education is preparing of environmentalists, who able to use their knowledge in a professional manner, taking into account the goals and objectives of sustainable development.

Providing quality training for future environmentalists is impossible without the organization of an educational process focused on the formation of professional competencies, which requires knowledge of the theoretical bases, tools and methods of solving professional problems; ability to analyze, predict their activity and independently choose the means and ways of action in certain situations; ability to self-development and self-realization of mastering modern scientific achievements and their implementation. It is forcing to find new ways of preparing future environmentalists in the conditions of rapid development of technologies and communications by using the method of projects – pedagogical technology, which includes a set of research, search, and problematic methods, creative in its essence. Therefore, when we talk about the project method, we are referring to the method of achieving the didactic goal through detailed elaboration of the problem (technology), which must be complete with a real, tangible practical result, designed in a certain way. The project method is based on the idea that constitutes the essence of the concept of "project", its focus on the result, which is obtained when solving a practically or theoretically significant problem.

"According to recent research, project work meets, to some degree, the expectations of its proponents in that the method improves – besides factual learning – the students' motivation, self-confidence, and critical thinking as well as their problem solving, decision making, investigative, collaborative skills. But there is evidence, too, that there exist barriers hindering the achievement of the objectives intended and striven for since neither students nor teachers always fulfill the necessary premises and qualifications completely. Teachers, for example, have difficulties to suggest and design challenging projects, monitor progress, give feedback and support when and where is needed, to create and maintain an atmosphere of study and work, and lastly develop tools for assessing the results. Correspondingly, students often feel ill prepared and overwhelmed by the complexity of the tasks at hand, i.e. they have not a clue how to define the problem, choose the proper methodology, find the necessary resources, revise plans and procedures if appropriate, keep deadlines and present the results fittingly. After all, projects can fail since few students are constantly

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disposed to self-directed, creative, innovative learning. In principle, they enjoy the freedom of action the project method offers them but, as in traditional settings, they frequently employ strategies of bargaining, shirking, and playing dumb in order to lessen, avoid or even resist the additional time, energy, and imagination required by project work." [5]. The method of projects always involves the solution of a problem, and the solution of the problem involves, on the one hand, the use of a variety of different methods and learning tools, and on the other hand – the need to integrate knowledge and skills from different science, technology, creativity. The results of completed projects should be reality and ready for implementation. So far, the method of projects has not been used in the preparation of environmentalists, cause previous studies are devoted to raising the level of ecological consciousness, culture and outlook; improvement of existing technologies of higher environmental education; formation of professional competence of environmentalists.

"The project method has several steps: the teacher and the students examine a certain environmental topic, they choose a problem which is important to them, and then they develop and carry out an action plan. With each step the students assume more and more the role of a manager able to treat environmental topics. Responsibility is passed on gradually from the teacher to the students; at the beginning it is the teacher who guides the process and establishes the main lines, later the students take over the project management, and the teacher becomes an observer. The teacher controls the advancement of the students, he ensures the possibility to change roles by developing the knowledge and skills of the students, assessing their performance with criticism, and introducing new ideas and methods in the learning process, thus eliminating the factors which limit their development" [6].

Thus, it is possible to formulate such hypothesis of research: the method of projects provides the higher level of formation of professional competences of future environmentalists, which in turn will increase their ability to work in the conditions of sustainable progress of society. In addition, the use of computer technology in the project training of future environmentalists will promote progress of their communication skills and processing results.

Methods

Research using project method by future environmentalists were used some methods: analysis, synthesis, modeling; pedagogical experiment; statistical analysis.

For the purpose of evaluation of future environmentalists, the criteria for the evaluation (Table 1) of their professional competences were determined [7], which conventionally called "project": K04. Ability to develop and manage projects; K17. Ability to independently develop environmental projects by creatively applying existing and generating new ideas and relevant programmatic learning outcomes; PR04. Know the legal and ethical standards for the assessment of professional activity, development and implementation of socially significant environmental projects in the conflicting requirements; PR05. Demonstrate the ability to organize collective activities and implement complex environmental projects, taking into account available resources and time constraints.

Table 1. Criteria formation of project competence.

The level of competence	**High**	**Enough**	**Medium**	**Base**
ECTS credits	90-100	74-89	60-73	35-59
Formation criterion	Ability to solve research and creative tasks by applying the project method	Ability to justify approaches to the implementation of different stages of the project	Ability to perform typical tasks under the guidance of a teacher / student	Have of basic skills, inability to organize and work as a team on a project

Material

The result of the implementation of project training is the development and protection of a portfolio of educational or scientific project, which involves the use of information and communication technologies and compliance with specific requirements for content and structure.

"Portfolio of project is a set of informational, didactic and methodological materials to the educational project, designed with the purpose of its effective organization and training of the subject" [8, p. 134].

We propose to determine the topic of students' research projects according to the topic of their qualification (course) work. This avoids the automaticity in the creation of individual elements of the e-portfolio, because students are interested in their portfolio not only respond the formal requirements, but also reveals the content of their qualification (course) work. They find a lot of useful information not only for their project portfolio, but also for their qualification work, they learn how to conduct research and to process its results, to build different types of graphs and diagrams. Creating a publication, presentation, blog and website allows you to diversify their qualification (course) work. It is especially useful to create a presentation on the topic of the project: students can use it both in defense of the project and in the defense of qualification (course) work.

An environmental project is a program or plan of consistent actions that is likely to improve the environmental state of an existing locality. In the context of the sustainable development concept, scale of project implementation may vary dynamically, depending on the number of participants and their place of residence. We trusted it as a protest from the pupil Greta Thunberg, who is struggling with global warming and becoming one of the most influential teens in 2018 for the TIME edition [9] are widely known around the world. In

August 2018, Greta made her famous by launching the first school strike for climate under the Swedish Parliament building. She came under the building every Friday, demanding that legislators support the Paris Climate Agreement. The main objective of the Paris Agreement is to prevent the global average temperature rise within 2°C (preferably not more than 1,5°C) in relation to pre-industrial period. The second goal of the agreement is to reduce greenhouse gas emissions to zero during the second half of the 21st century. In the conditions of realization of the concept of sustainable development of mankind, 21 main indicators of which change, track the results of each country have been identified (Fig. 1).

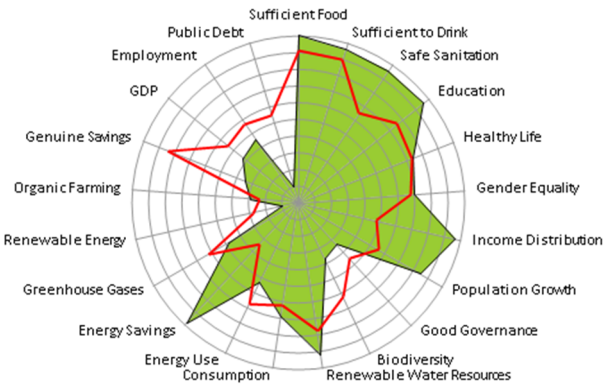

Fig. 1. The spiderweb shows the score of each of the 21 indicators of the Ukraine, on a scale of 1-10 (10=sustainable, 1=not sustainable). The line is the weighted average score of all countries (http://www.ssfindex.com/).

The use of this web resource (http://www.ssfindex.com/) makes it possible to track the dynamics of change for each country indicator (fig. 2) and to determine whether the government and the population of the country are taking action to implement the concept of sustainable development.

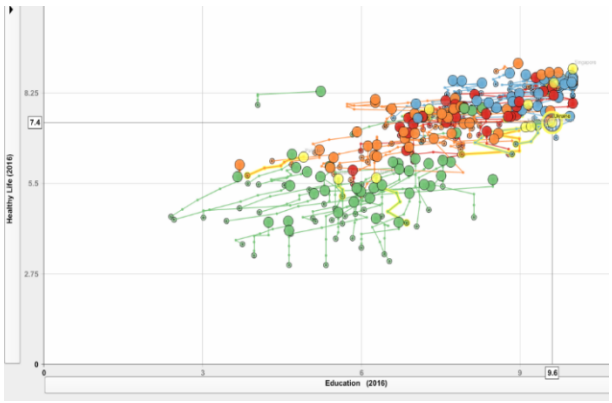

Fig. 2 Dynamics of change of selected indicators (Education and Healthy Life).

Also with the interactive map of the world (Fig. 3) students can track the same indicators simultaneously for all countries of the world.

However, it will be much more valuable not to look at these indicators, but also to perform an active benchmarking of data for different countries, for example, using the Excel spreadsheet (Fig. 4), which contains these indicators from 2006 to 2016.

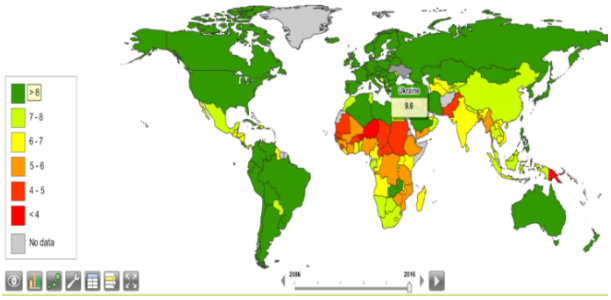

Fig. 3. Interactive map of the world indicators of sustainable development.

	A	K	L	M	N	O	P	Q
1	2016	Environmental Wellbeing						
2		Natural Resources			Climate &Energy			
3		Biodiversity	Renewable Water Resources	Consumption	Energy Use	Energy Savings	Greenhouse Gases	Renewable Energy
4		Indicators						
146	Turkmenistan	3,4	1,0	5,5	1,0	2,0	1,0	1,0
147	Uganda	7,5	9,8	6,1	9,3	5,4	9,8	8,3
148	Ukraine	3,7	9,2	6,9	5,3	9,8	4,8	1,0
149	United Arab Emirates	5,5	1,0	3,8	1,0	3,8	1,0	1,0

Fig. 4. Excel spreadsheet, which contains indicators of sustainable development from 2006 to 2016.

It will also be valuable for future environmentalists to analyze the dynamics of changing each indicator for the selected country and identify the cause of its rise or fall.

After that, we propose to future environmentalists to analyze the table 2 and choose the topic of environmental projects in two directions:

1) to maintain the level of the achieved indicator and its dynamics until growth;

2) to increase of the selected indicator.

For example, for the Renewable Water Resources indicator we observe a negative trend (a decrease of 0.1), and despite the sufficiently high value of the indicator (9.2 out of 10), we should pay attention to it, because the world's water resources are suitable for consumption, have decreased significantly over the last 20 years.

According to this indicator, we offer students a number of indicative topics of environmental projects:

- "Save the small river – save the ocean";
- "Clean River – Healthy Man";
- "Monitoring domestic water consumption";
- "Responsibility time: how do I pollute the water?"
- "We do not know the price of water until the well runs dry";
- "River death – a tragedy of the region";
- "Helping Waterfowl";
- "In the lens – the reservoir";

• "ECO-style living: a phosphate-free household";
• "We reduce the amount of household waste into water";
• "Collection of mechanical waste in reservoirs without harm to their inhabitants";
• "Collecting greasy stains from reservoirs after shipwrecks";
• "Environmental problems of using household chemicals".

Table 2. Indicators of sustainable development (Environmental Wellbeing) from 2006 to 2016 for Ukraine

Ukraine	Environmental Wellbeing						
	Natural Resources			Climate & Energy			
	Biodiversity	Renewable Water Resources	Consumption	Energy Use	Energy Savings	Greenhouse Gases	Renewable Energy
2006	3,7	9,3	5,8	3,9	2,2	3,8	1,0
2008	3,7	9,1	6,0	4,1	3,9	3,6	1,0
2010	3,7	9,1	4,9	4,2	6,0	3,6	1,0
2012	3,7	9,2	6,1	4,2	5,4	4,2	1,0
2014	3,7	9,2	5,2	4,6	6,9	4,0	1,0
2016	3,7	9,2	6,9	5,3	9,8	4,8	1,0
Progress Scores 2006-2016	0,0	-0,1	1,1	1,4	7,7	1,0	0,0

Stages of implementation of environmental project:
- **team formation** (usually students of specialties "Ecology");
- **selection and formulation of the project theme** (for example, the specified project theme might look like: "Environmental problems of using household chemicals (for example, dishwashing detergents)");
- **determination of the relation to the problem**: what significance this project will have for the project participants, for other people; what benefit will society bring to the implementation of the project;
- **planning for a project** begins with a collective discussion. This is, first and foremost, an exchange of views and a reconciliation of students' interests; developing primary ideas based on existing knowledge and discussing controversial issues. Tutor, project manager should focus students' attention on the overall theme of the project, on subtopics, on their relationship, the course and timing of work on the project; encourage them to research independently; to group and summarize with the project implementing students ideas in the most clear and comprehensible form for them, to determine the direction of the research work and to help the students to formulate 5-6 related subtopics within the research topic and to determine the timing of individual tasks; start a project implementation journal.
- **examination the problem**: find the right information, meet with experts, make a list of necessary materials, equipment and more. This is a stage of independent research, acquisition and analysis of information, during which each student: refines and formulates his own task, based on the purpose of the whole project as and the task of his group in particular; searches and collects information, analyzes and interprets the data obtained.
- **identifying ways to solve the impact of the dishwasher on water**. At this stage, the obtained information was systematized, so the tutor should help groups or individual students summarize the obtained results for each of the tasks and determine the ways in which they can be accomplished.
- **planning of practical activities**: analysis of the chemical composition of popular dishwashing detergents, research of the ability to dissolve the individual constituents of detergents in water and their impact on living organisms, selection of means to neutralize the negative impact of constituent detergents on living organisms;
- **implementation of practical actions aimed at "health improvement" of nature**: analysis of the results of experimental studies and search for the least harmful detergent;
- **discussion of the results of the work:** group discussion, round table, consultations with the project manager (tutor), consultations with experts. At this stage, students reflect on the data and ways to achieve the result; discuss and prepare the final presentation of project results. The students not only present the results and conclusions, but also describe the techniques by which information was obtained and analyzed; tell about the problems that they had to face when working on the project. In order to successfully organize the presentation of the finished project, the tutor - project manager , along with the students, think through of: how best to apply each project participant's individual intellectual and communicative abilities,; time for preparation and presentation; presentation scenario; project presentation form; prospects for further work on this project.
- **presentation of the work should include:** a description of the project, including the object, subject, purpose, tasks, materials, actions, results; suggestions or ideas; illustrations or computer graphics; interpretation (of specific facts, events, processes, etc.); evaluation and analysis: charts or graphs; justification (conclusions, suggestions, recommendations, etc.);
- **planning of further ecological work:** analysis of the impact of project results on the selected indicator and deciding on the continuation of projects within this indicator by popularizing the project, spreading it to more consumers.

For creating all these elements we use of G Suite package, which has all the necessary cloud services not only for the development of collective projects, but also for the work in the mode of shared access. It is enables the teachers (project managers) to monitor the progress of the project, because cloud computing is a data processing technology in which software is provided to the user as an Internet service. The user has access to their own data, but cannot manage and have not to take care of the infrastructure, only operating system (OS) and software with which it operates. Cloud computing is a paradigm in which information is constantly stored on servers on the Internet and temporarily cached on the client side, such as personal computers, game consoles, laptops, smartphones, etc. [10].

There are three main areas of implementation of "cloud computing" [11]:
- SaaS, Software as a Service. Almost any application that works through the World Wide Web.
- PaaS, Platform as a Service. It allows you to create and implement hosting-based applications using the programming language and packages from the provider. These include G Suite from Google.
- IaaS, Infrastructure as a Service). This includes the use of server and disk space away from the user, which is also typical of Google Drive.

Cloud computing includes the concept of Web 3.0 and other technological trends that are common to the belief that the Internet is able to satisfy user needs for data processing. For example, G Suite provides software online (without installation), accessed through an Internet browser while the software and data are stored on Google's servers.

The project activity in cloud environment has characteristics such as [12]: interdisciplinarity (integrated learning), collaboration (active communication and teamwork), availability of results (application of scientific and technical knowledge in real life), preparation students for technological innovation of life.

The basics of the project method was showed on the example of technical disciplines [13].

Results

Considering that, the teaching of technological and informational disciplines for future environmentalists is in interaction with other factors (scientific measures, industrial practice or internship at the enterprise, cooperation with potential employers) and is a multifactorial, trial implementation of the developed methodology in the education. Competency Standards of future environmentalists demanded carrying out of pedagogical experiment, which provides detection of its efficiency.

Whereas the pedagogical experiment in our study was aimed at establishing the effectiveness of the formation project competence of future environmentalists, it was a comparative experiment. For its conducting two groups were formed – experimental and control. The experiment was organized in such a way that the results of implementation of the project method in the teaching of future environmentalists for experimental groups were compared with the results of students from control groups (where teaching was carried out according to the traditional method) using the same methods diagnostics.

The experimental and control group implement different variants of experimental work, with all the conditions of the educational process in these groups were the same except for the condition that was dependence by the establishment of methodological innovations and was subject to testing. The sampling amount formed taking into account the number of students of the specialty "Ecology".

The 410 students participated in the molding experiment. The 203 were assigned to the experimental group, 207 were assigned to the control group (this division was made taking into account the distribution of students in academic groups).

The differences between the experimental and control samplings (Fig. 5) were determined using the Fisher criterion φ^*. The test of the statistical hypothesis against the coincidence of the differences in the results was made at the level of significance $\alpha = 0{,}05$.

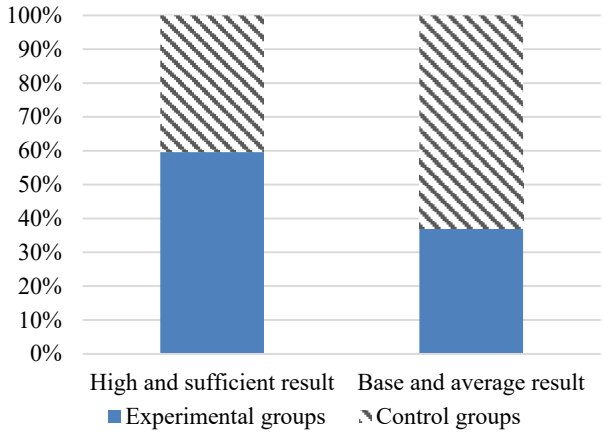

Fig. 5. The proportion of students (in %) who have an appropriate level of project competence.

We construct a table 3 of output data of the level of learning achievement of two samplings: control and experimental groups to determine the Fisher criterion.

Table 3. The results of the formation stage of the pedagogical experiment.

Sampling	High and sufficient result			Base and average result			Sum	φ^*
	Number of students.	%	The value of φ (in radians)	Number of students.	%	The value of φ (in radians)		
Experimental groups	139	68,5%	1,95	64	31,5%	1,19	203	5,01
Control groups	96	46,4%	1,50	111	53,6%	1,64	207	1,04

The critical value of φ^* for the level of statistical significance $\alpha = 0{,}05$ is $\varphi^*_{cr} = 1{,}64$). It turned out that the value of φ^* exceeds the critical value, which confirms the effectiveness of the auto-methodology to increase the level of project competence of future environmentalists.

Thus, the level of project competence of future environmentalists who were part of the experimental group increased significantly. This means that, the using of the project method directly affects the quality of professional training and leads to statistically significant positive dynamics of the level of professional competence of students.

It was proved, that created method of formation the project competence of future environmentalists is more

effective than traditional. The results of students' activity in realization of their projects based on the study of the impact of industrial and urbanistic forms of human activity testify to the effectiveness of the developing of the project competence of future environmentalists.

Thus, the hypothesis of the study was confirmed that the project method provides a higher level of professional competences of future environmentalists, which in turn will increase their ability to work in the conditions of sustainable development of society, and the use of computer technologies in the project training of future environmentalists contributed to the development of their skills communication and speed of processing results.

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