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**PEDAGOGICAL TECHNOLOGIES OF REALIZATION
OF EDUCATION FOR SUSTAINABLE DEVELOPMENT:
COMPARATIVE RESEARCH**

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Abstract

The study identifies pedagogical technologies, which are effective for an implementation of United Nations Economic Commission for Europe (UNECE) Strategy for education for sustainable development (ESD). An implementation of ESD principles takes place at the varying degrees on different levels of formal, non-formal and informal education; various pedagogical technologies are used. It is important to identify the most effective and promising technologies, taking into account national and cultural features of different countries, including Russia. Main purpose of our research is an identification and comparative analysis of ESD pedagogical technologies of different levels of education from different countries and justification of their potential application in Russian Federation. Based on the best practices of UNECE countries, we aim to justify an implementation of affordable and effective educational technologies; it will allow realizing ESD principles in practical work of educational institutions of different levels and types (kindergartens, schools, colleges, universities, organizations of additional education etc.) in Russian Federation. In the course of our study, we analysed national reports on the implementation of UNECE Strategy for ESD (phase III, 2011–2015) from 37 countries. We composed the list of suitable pedagogical technologies, have compiled their classification and ranking. We have revealed and classified pedagogical technologies which are used for an implementation of UNECE Strategy for ESD in the system of formal, non-formal and informal education. We have justified theoretical possibility of their application in Russian Federation.

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1. Introduction

Concept of sustainable development (further in text: SD) was developed in 1980–1990-s as a certain strategy of civilization development, which is alternative to the strategy of economic growth (World Commission..., 1987). It was accepted on the 70th session of the General Assembly of The United Nations (further in text: UN). The Resolution A/70/L.1 “Transforming our world: the 2030 Agenda for sustainable development” has attracted an attention of the global community to the importance of SD. An education is not only an independent goal of SD, but it is also a tool for achievement of 16 other goals (UN, 2015). An important role of the education was identified on the 2nd United Nations Conference on environment and development.

As it follows from the paragraph 36.3 of “Agenda 21”, which is adopted by the representatives of most countries, including Russia, “Education, including formal education, public awareness and training ... is critical for promoting sustainable development and improving the capacity of the people to address environment and development issues... Both formal and non-formal educations are indispensable to changing people's attitudes that they have the capacity to assess and address their sustainable development concerns. It is also critical for achieving environmental and ethical awareness, values and attitudes, skills and behaviour consistent with sustainable development and for effective public participation in decision-making. To be effective, environment and development education ... should be integrated in all disciplines, and should employ formal and non-formal methods and effective means of communication” (UN, 1993, p. 439).

In 2003, UN General Assembly declared a decade 2005–2014 “The Decade of education for sustainable development” (UN, 2003). In 2005, UN Economic Commission for Europe (further in text: UNECE) has adopted Strategy for education for sustainable development (further in text: ESD) (UNECE, 2005). Educational technologies are aimed to be an important part of the realization of this strategy.

2. Problem Statement

Term “pedagogical (or educational) technologies” is used for denomination of both materialistic tools and theoretical basis for support of teaching and education. It is a way to implement the content of education, which includes system of forms, methods and means of teaching, which provide most efficient achievement of stated objectives (Calfee, 2006; Ross, Morrison, & Lowther, 2010; Selevko, 2005; Selwyn, 2011).

We can propose a classification of pedagogical technologies in the following generalized way: 1) traditional technologies (lesson, lection, seminar, excursion, conference etc.); 2) project technologies (project, research, experimentation, modelling etc.); 3) interactive technologies (games, group- and problem-based learning, case study etc.); 4) information and communicative technologies (computer, electronic, digital, mobile, online and cyber-based teaching, multimedia and virtual learning media etc.)

Paragraph e) of the article 33 of UNECE Strategy for ESD states that a wide range of teaching methods, and, particularly, active, specific process- and problem solving-oriented, which are adapted to the needs of students, should be applied.

In addition to traditional technologies, new educational technologies, such discussions, conceptual and perceptual mapping, philosophical inquiry, value clarification, simulations, role playing, games, scenarios, modelling, ICT, surveys, case studies, excursions and outdoor learning, learner-driven projects, good practice analyses, workplace experience and problem-solving, should be used.

In 2005–2006, UNECE expert group has developed a set of indicators for ESD. Second meeting of UNECE Steering committee on ESD (Geneva, 4–5 December 2006) has approved a format for reporting on implementation of the UNECE Strategy for ESD within the framework of the UN Decade on the basis of 6 groups of indicators: 1) Ensure that policy, regulatory and operational frameworks support the promotion of ESD; 2) Promote SD through formal, non-formal and informal learning; 3) Equip educators with the competence to include SD in their teaching; 4) Ensure that adequate tools and materials for ESD are accessible; 5) Promote research on and development of ESD; 6) Strengthen cooperation on ESD at all levels within the UNECE region (UNECE Steering committee..., 2006). Taking into account an importance of pedagogical technologies in achieving the goals of the Strategy at its final stage of its implementation (2011–2015) and changes in International standard classification of education (further in text: ISCED), as adopted by UN Educational, Scientific and Cultural Organization / UNESCO member states in 2011 (UNESCO, 2012); in 2014 the list of indicators was supplemented. In particular, an indicator 2.1 “SD key themes are addressed in formal education” was supplemented by sub-indicator 2.1.3 “Are teaching / learning methods that support ESD addressed explicitly in the curriculum / program of study at various levels of formal education?”, which provides an assessment of the application of certain pedagogical technologies at different levels of education in accordance with the ISCED. Al-so, it is necessary to reflect information on informal education (UNECE Steering committee..., 2014).

Significant amount of information about indicators for ESD, that was published in the national implementation reports of the UNECE Strategy for ESD, in our opinion, is not analysed properly yet.

3. Research Questions

Identification and comparative analysis of ESD pedagogical technologies of different levels of education from different countries.

Identification of opportunities for application of these technologies in the Russian Federation.

4. Purpose of the Study

The purpose of this study is to identify effective teaching technologies that allow implementing ESD in different countries, including Russian Federation.

5. Research Methods

We use comparative pedagogical approach in our research. Based on the data analysis of sub-indicator 2.1.3 from 37 national implementation reports of the UNECE Strategy for ESD, phase III (2011–2015) (UNECE, 2015) (further in text: national implementation re-ports, NIR), that were presented on the 10th meeting of the UNECE Steering committee on ESD (Geneva, 8–9 June 2015), we defined

main pedagogical technologies in ESD and ranked them according to the frequency of their application in different countries and at different levels of education.

As a result of comparative analysis of these technologies, we determined the possibilities and features of their implementation in the Russian Federation.

6. Findings

In the Table 01 we present main pedagogical technologies which are used in ESD in countries studied at different levels of education: 0) early childhood education; 1) primary education; 2) lower secondary education; 3) upper secondary education; 4) post-secondary non-tertiary education; 5) short-cycle tertiary education; 6) bachelor's or equivalent level; 7) master's or equivalent level; 8) doctoral or equivalent level.

Table 01. Pedagogical technologies (teaching methods), which are used in ESD (number of countries)

Technologies / methods (symbol)	ISCED levels									
	0	1	2	3	4	5	6	7	8	
Discussions (D)	19	27	29	32	19	19	23	23	20	
Conceptual and perceptual mapping (CPM)	10	20	22	25	15	17	19	20	18	
Philosophical inquiry (PI)	3	12	15	22	14	15	21	22	18	
Value clarification (VC)	13	20	24	29	17	20	20	20	18	
Simulations, role playing, games (SRPG)	28	30	30	31	18	19	21	18	14	
Scenarios, modelling (SM)	12	14	20	24	15	18	18	18	15	
ICT	11	27	29	31	19	20	22	21	21	
Surveys (S)	3	14	21	27	16	19	20	22	20	
Case studies (CS)	4	13	17	26	17	20	23	22	19	
Excursions and outdoor learning (EOL)	27	32	31	31	19	16	18	18	14	
Learner-driven projects (LDP)	10	17	24	27	18	17	18	18	17	
Good practice analyses (GPA)	6	11	15	22	15	17	19	19	18	
Workplace experience (WE)	8	10	15	20	19	19	20	19	17	
Problem-solving (PS)	13	22	22	29	18	20	22	21	18	

It should be noted that certain levels of ISCED do not exist in some countries (for example, levels 4 and 5 do not exist in Ukraine (NIR. Ukraine, 2015).

Some countries did not present enough data to be included in this table (Switzerland, Canada, Andorra, and Finland). So, Finland explains this by the fact that educational institutions and teachers have autonomy and use variety of technologies; it is impossible to provide accurate information on this sub-indicator.

Apart from the mentioned above methods, Hungary added public services as one of the technologies used in the stages of education 3 to 5. Latvia added method of the storytelling, which is used on the level of education 0. It is noted in the Latvian report that the description of methods is given in every education program. Teachers choose to use most appropriate technologies, particularly, depending on the age of the students: for example, in primary school they use more games, and in secondary school they use more discussions. Scientific knowledge is the most commonly used method regardless of the age

of the students. There are evidences that interactive technologies which are based on dialogue and problem-based approaches and contributing to the development of thinking and competence, including responsibility for sustainable development and correct decision-making, are very efficient i.e. supportive to SD ideas (NIR. Republic of Latvia, 2015). Also, some methods of formal ESD, such field research, simulation games, discussions, experiments, research, observation and brainstorming, are used in non-formal education (NIR. Cyprus, 2015). They can be implemented in different ways: comprehensively, in a separate subject or module, block of the curriculum; diffusely, in separate subjects (modules) of general and professional components of education and in practical education; interdisciplinary, in school projects.

“Transversal” topics of ESD can be studied using project methods or an integrated approach. These technologies need specific requirements to the professional competence of teachers; so, schools often cooperate with various state and public organizations, employees of which help in the development and implementation of programs (NIR. Czech Republic, 2015).

In the Kyrgyz Republic, not all of these methods and only at some levels of education are used, but interactive educational technologies and project activities are used increasingly. Less actively, but the same process occurs in the system of vocational education (NIR. Kyrgyz Republic, 2015).

In the Table 02 we present results of the ranking of technologies from the Table 01 according to the frequency of the usage. We composed this ranking (1 corresponds to “most frequent”, 14 corresponds to “least frequent”), based on the mentioning of certain technology in the national implementation reports.

Table 02. Ranking of pedagogical technologies used in ESD

Rank	ISCED levels								
	0	1	2	3	4	5	6	7	8
1	SRPG	EOL	EOL	D	D	ICT	CS	D	ICT
2	EOL	SRPG	SRPG	EOL	EOL	PS	D	CS	D
3	D	D	D	SRPG	ICT	VC	ICT	PI	S
4	VC	ICT	ICT	ICT	WE	CS	PS	S	CS
5	PS	PS	VC	VC	SRPG	D	SRPG	ICT	PI
6	SM	VC	LDP	PS	PS	WE	PI	PS	PS
7	ICT	CPM	PS	LDP	LDP	SRPG	VC	VC	VC
8	CPM	LDP	CPM	S	VC	S	WE	CPM	CPM
9	LDP	SS	S	CS	CS	SM	S	WE	GPA
10	WE	M	SM	CPM	S	LDP	CPM	GPA	WE
11	GPA	CS	CS	SM	CPM	CPM	GPA	SRPG	LDP
12	CS	PI	PI	PI	SM	GPA	SM	SM	SM
13	PI	GPA	GPA	GPA	GPA	EOL	LDP	LDP	SRPG
14	S	WE	WE	WE	PI	PI	EOL	EOL	EOL

Traditional methods, widely used at all levels of education, especially at the levels 2 and 3, include conversations, discussions and dialogues, in which collective judgment of certain issues, problems, comparing information, ideas, opinions, proposals, people's attitudes, feelings and intentions, assessments and positions are revealed. The objectives of the discussions can be different: training, diagnostics, changing of attitudes, stimulating of creativity, etc.

Value clarification, case studies and good practice analysis are well known methods. In a broad meaning, they mean organized educational activities aimed at establishing connections, revealing of

common and sustainable in educational, economic and social systems (NIR. Kyrgyz Republic, 2015). Unfortunately, they are not very common in ESD (Table 02). Extracurricular activity is an important part of educational process and of the leisure activity of students. It exists in many forms: competitions and Olympiads, lectures, subject groups, electives, amateur performances. Excursions that allow to organize observation and study of various objects and phenomena in normal, natural conditions, such nature, historical places, enterprises, etc. or in museums and exhibitions, have significant potential for ESD.

Excursion tour, which is built on the principles of visibility, independence and activity, with the appreciation of local features, is one of the most valuable pedagogical methods and it is widely used in preschool institutions and schools in different countries. Project technologies are separate group of educational technologies. The method of projects is a way to achieve the didactic goal through a detailed development of the problem, which should end with a real result, which is decorated in one way or another, which can be seen, understood and applied in practice.

Project method as a pedagogical technology assumes an application of a set of research-, search-, problem-oriented creative methods. This method is commonly used in ESD at the levels of education 2 and 3, when students can independently use information, conduct research, analyse and prepare results.

As an example, we can consider a competition “Choose the sun”, which is organized by the Foundation for environmental protection (Poland). This competition is aimed at the dissemination of knowledge about renewable energy sources. Students of all ages and institutions (general and primary vocational schools, technical schools) participated in this competition. To take a part in this competition, teams of students, with the participation of a mentor, study the processes of electricity production (primarily photovoltaic), measure the energy consumption of their own homes, and then design for them the photoelectric systems for them.

At the second stage, the teams have to share acquire knowledge with the local community during the preparation of presentations for conferences to which experts are invited. The winners of competition will be awarded (Postaw na słońce, 2018).

Thematic and philosophical inquiries and surveys are very similar to the project method. Data for case studies on a particular issue are usually collected from different sources, using different methods, such as observation, interviews, questionnaires, etc. Philosophical inquiry suggests the search for solutions to ideological, existential problems. Survey is a purposeful analytical and synthetic perception of reality with the help of sense organs (NIR. Ukraine, 2015). These methods are most developed at higher levels of education. Preschool education in Germany, Netherlands and Austria demonstrates an interesting example of an application of the philosophical inquiry method. Philosophical topics are mainly discussed with children in the form of questions, in spontaneous “everyday life” conversation: children often ask “why?”.... Also, it is possible to organize a weekly “workshop” for answers to questions and “box of questions”. Teacher moderates the lesson and pays an attention to the observance of pre-established rules. So, students will develop both philosophical style of thinking and the culture of dialogue.

The general toolkit of philosophical techniques relating to sustainable development topics include many issues (is it always like this? is everything like this? could it be in different way?..), for example: “What would happen if we were all the same? What would be good and what would be not good?”,

“Where things, living things and processes, like plants, a motorcycle, a hydroelectric power station, get their energy from?”, “What is difference between culture and nature?”, «Which of my feelings is most susceptible to natural phenomena?”, “What is a friendship? Is it possible to be a friend with a tree?” etc. (Müller & Schubert, 2011).

Unfairly, modelling method, which studies properties of objects and phenomena (prototype) using their substitutes (models), is not very popular in ESD. The prospects of this method are very promising, especially in preschool education, when the child just begin to learn about the world. Method of mind maps, also known as mental, conceptual, and associative or perception maps is modern and effective form of educational modelling. This is a way to reflect the process of system thinking with the help of special schemes. Similar maps are used for creating, visualizing, structuring and classifying ideas, and also as a means of organizing the decision-making. This method of teaching is most developed at the primary levels of education, but in general it is poorly used.

Interactive technologies are based on the interaction between students and teacher, in which the main content of ESD is revealed. For example, problem-based learning involves the creation of controversial (problematic) situations in the minds of the students under the guidance of the teacher and the organization of the active independent activities for their solution, as a result of which creative mastery of knowledge, abilities, skills, development of thinking cognitive and social competencies will be developed. This pedagogical technology is used at almost all levels. It helps to see real links between causes and ways of addressing and preventing problems through the prism of social, economic and environmental sustainability.

This method creates a significant practical opportunity to contribute to the solution of problems of local communities; for example, students conduct an inspection, develop a plan for the installation of ramps in those buildings of their settlements, that are not accessible to persons with disabilities, then they offer it to local authorities and authorities take a decision. With this approach, students became active citizens; they develop social responsibility and personal efficiency. Game as an educational technology can be used at different levels of education, and not only for children of preschool and primary school age. For example, the game “Green manager” was developed in Ukraine, and then it was tested within the frame-work of the national initiative “Green class”. This game is focused both on improving the overall level of ideas about sustainable development and on the formation of special knowledge on climate change (NIR. Ukraine, 2015).

ICT (informational and communicative technologies) is a set of methods, techniques and means of providing pedagogical conditions for targeted trainings and self-study on the basis of computer technologies, internet, interactive software and methodological support, which models a part of functions of a teacher on the presentation, transmission of information, and management of educational and cognitive personality-oriented activity of students. ICT are now actively introduced into the ESD process at all stages in different countries. However, it should be noted that ICT, and especially virtual reality, can be addictive, and, therefore, should not be abused. If ICT do not support a student's morally responsible consciousness and sustainable behaviour, but lead to any form of radicalism, the benefits turn into risks.

Our experience shows that ICT in general, not only in education, has become the engine of socio-economic development in many countries, and ensuring of guaranteed free access to information for

citizens is one of the most important tasks of sustainable development. Areas of ICT application in ESD can be diverse: interactive communication; knowledge generation and exchange; cooperation with other educational, research and other organizations, etc. Malta is one of the countries, in which ICT are used at all levels of ESD. Within the framework of the Foundation for environmental education “Eco-School” program, ESD ideas are promoted in formal and informal education sectors on the basis of international standards, which lead to the strengthening of the ideas of environmental ethics, sustainable lifestyle, personal and institutional changes in the direction of sustainability (EcoSkola Malta, 2019).

7. Conclusion

Report on the implementation of the UNECE Strategy for ESD for the phase III (2011–2015) was not presented by Russian Federation (UNECE, 2015).

While ESD is being actively introduced into formal, non-formal and information education in many countries, empirical studies on the effectiveness of various pedagogical ESD technologies in the Russian education system are very limited (Ermakov, 2013; Ermakov, 2016; Kankovskaya, 2016; Zhevlakova, 2013).

The main feature of ESD is that it should use not only traditional technologies, for example, lesson-lecture or lesson-seminar; it is impossible to build education on predesigned questions and answers. Questions related to SD are in most cases very complex, and there are no unambiguous answers to them.

The pedagogical approach should be based on a variety of methods and technologies. Among the most promising, in our opinion, are ICT, practical participation of students in solving specific environmental problems, development and implementation of projects, concept and perceptual mapping.

The method of projects is widely implemented in Russia, but its understanding often leads to the fact that students prepare a presentation on the topic, while it is necessary, especially in the framework of ESD, to know how to do an independent research, data analysis, practical actions, obtaining an original product, evaluation of semi-finished results.

Conceptual and perceptual mapping is very new direction in Russian education. An application of this method in the learning process makes it possible to take into account the level of cognitive development of students and to form their universal learning activities: search and selection of necessary information, structuring of knowledge, thinking about the ways and conditions of action, monitoring and evaluation of process and results of activity, analysis of objects in order to identify features (essential, insignificant), establishing cause-and-effect relationships, building a logical chain of reasoning, presentation of an information as graphic schemes, tables.

Conceptual and perceptual mapping will contribute to the systematization of knowledge, cognitive activity and to the interest in the study of SD problems. It should be noted that such well-known technologies as game, excursion or value clarification (especially at the initial levels) are extremely important and should be actively used.

In fact, educational technologies for ESD should be directed to the co-action learning in a way that the students saw the complete picture of the world based on their own experience, observations and development competencies to ensure sustainability.

To continue this study, we plan to analyse materials of the national implementation reports for 2017-2019, which will allow estimating dynamics of the application of educational technologies for ESD in different countries, including Russian Federation.

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