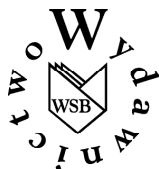# Education
# in the Core of Sustainability
## Voices from the Baltic Sea Region

# Edukacja a rozwój zrównoważony

## Doświadczenia z regionu Morza Bałtyckiego

redaktor naukowy

Arnold Bernaciak

# Education
# in the Core of Sustainability
## Voices from the Baltic Sea Region

volume editor

Arnold Bernaciak

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# Introduction

*"Education is an essential tool for achieving sustainability"*

*R. McKeown*

*"Education is an essential tool for achieving a sustainable future"*

*C.A. Hopkins, R. McKeown*

*"In recent years there has been a growing consensus
that environmental education should be orientated
around the idea of 'sustainable development"*

*M. Bonnett*

*"Around the world, many people in community groups,
in government agencies, and in schools, colleges and universities
are using educational processes to help build a degree
of sustainability into their lives and those of their neighbours"*

*D. Tilbury, R.B. Stevenson, J. Fien, D. Schreuder*

These are just a handful of quotes collected from prefaces to the most popular publications in the area of education and education for sustainable development. Clearly, educational activities are believed to be the foundation of sustainable development. They enable people to behave in an environmentally responsible way and are part of a broader process aimed at improving and developing public awareness on the way towards sustainability. The main question that has to be answered is how to do it properly: how to convince people to think, behave and develop in a sustainable way?

This volume of "Studia Periegetica" collects different points of view on education for sustainable development. It presents personal experiences, universal tools, methods and a set of current data and information from different areas associated with sustainable development. The introductory part presents basic, theoretical issues and contains accounts of some personal experience of lecturers and teachers. The first article, written by Victor Golubiev, addresses the role of

education in building a sustainable society. The author analyses the educational process from a phenomenological point of view and proposes dividing it into four parts and distinguishing three levels within the ESD system. This is a new approach to the ESD system. The next article, written by Anna Bernaciak and Agnieszka Kozłowska, focuses on innovative teaching methods. After presenting the theoretical background, the authors analyse selected methods and describe their applicability by referring to specific examples in educational settings. The topic is discussed in the context of the main challenges in teaching adults and can be regarded as a useful guide to teaching methods. The article by Roman Zinko, Maria Ivanchenko and Uliana Hanas describes the use of memberwise disjunction to classify teaching methods depending on student personality type. The approach provides a short description and analysis of teaching methods from the perspective of their usefulness. It identifies the potential of each method and ways in which it can be improved, developed and implemented.

The next two articles should be of interest to people responsible for creating teaching programs, educational courses or study programs. In the first one, Ann-Sofie Hermanson describes how to implement ESD in an Environmental Policy course. The conclusions from this article can serve as guidelines on how to structure students' discussions on environmental cases in small seminar groups and, more generally, on how to teach ESD. The same topic is addressed by Anna Belova and Elena Korshuk. In their article entitled *ESD as a positive side effect of international activities: case-study of the project CROSSROADS 2.0*, they describe an implementation of ESD in a multinational educational project. They report their experiences, project outcomes and provide suggestions on how to conduct similar projects successfully. This article introduces another part of the volume – examples and experiences from different educational fields. Sviatlana Gadzaova, Halina Murauyova and Maryia Urban describe an interesting approach to preparing future primary school teachers. It involves implementing aspects of sustainable development in the mathematics teaching programme. This approach could be carried out effectively by appropriately trained teachers while creating added value at the same time. In another article, Tatyana Belyaeva presents a way of teaching biomonitoring through English. The author describes how to implement the interdisciplinary approach to teaching English using elements of content and language integrated learning methodology. The approach combines environmental science, sustainable development and the English language in order to help students obtain professional competence in a wide range of skills. Kalina Sikorska-Zimny and Luciano Beneduce describe a modern teaching approach for agri-food sciences, which focuses on sustainability and climate change issues. The authors describe a model of developing interdisciplinary teaching modules and possibilities of teaching sustainable management of agri-food systems. They

show how their ideas can be implemented in teaching programmes of the food science subjects.

The last two articles are devoted to the subject of climate change, addressing challenges and global initiatives in this area. In the first one, Oleksandra Khalaim analyses the usefulness of climate change games in education. According to the author, role playing games can be used as an effective tool in Education for Sustainable Development to bridge the educational gap in this field. She presents 12 games and their applicability for teaching purposes. The second article, written by Larysa Cherniak and Margaryta Radomska, is a case study that could be used in educational practice. The authors analyse local climate effects associated with the Lviv Danylo Halytskyi International Airport and the impact of aircraft emissions on the local climate. They use their own calculations of radiative forcing of aircraft emissions and the radiative impact of clouds in the surrounding area of the Lviv airport.

I hope the contributions included in the present issue will prove useful for our readers.

*Arnold Bernaciak*

Victor Golubev*

# Some Aspects
# of the Role of Education
# in Building a Sustainable Society

**Abstract.** The following article examines aspects of education for sustainable development. The author argues that the most effective way of changing the ecological situation is to alter the social reality through appropriate education. Assuming that a structural analysis of the education phenomenon can improve our understanding of how education works, the author proposes dividing the educational process into four components, called fields of education. Based on the idea of fields of education, the author also proposes distinguishing three levels within the ESD system – ecological enlightenment, ecological consciousness and ecological culture. The author also gives some practical examples of how we can use these classifications in ESD.

**Keywords:** education, social order, social governing, ESD, field of education, ecological enlightenment, ecological consciousness, ecological culture

## 1. The Importance of Education
## in Building Sustainable Society

We all now face such global problems as the greenhouse effect; air, water and noise pollution; soil corruption; the extinction of species; etc. And with every year we are closer to the situation when there will be no chance to ignore the consequences of global ecological problems. The point is that the vast majority of global problems has social nature and thus can be solved only through the social reality altering. As Anthony Giddens said: "A fundamental problem is achieving the lifestyle changes that would lead to lower emissions" [Giddens 2009: 11].

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One of the main fields of interest of modern social sciences is the idea of social order and the problem of its establishing and maintaining. In general, the concept of sustainable development is a part of more general idea of the sustainable society. The point is that the concept of society is still rather sophisticated and it is really hard to get the comprehensive definition for what society really is, as it was mentioned by the famous German sociologist Niklas Luhmann: "The word "society" does not refer to a clear-cut idea. Even the common term "social" has no incontestably objective reference" [Luhmann 2012: 1]. One can imagine the contrariety of the idea of social order in the modern humanities and as a result the real challenge in the defining of the social governing concept. In order to make the idea clear the next working definition for social governing should be proposed – the specific type of the subject-to-subject activity aimed on the setting and achieving of certain goals through establishing and maintaining of the certain social order by appropriate means and methods using the power resources and also the process of implementation of these activities. I consider the education management to be one of the most important methods of social governing, especially in the reality of the Information society.

Plato considered any society to be effective only in case it has the ultimate Aim of its existence. The absence of this aim leads to the uncertainty of the social order requisitions and thus no one can pretend to build an effective sustainable society. "Upon the educational side, we note first that the realization of a form of social life in which interests are mutually interpenetrating, and where progress, or readjustment, is an important consideration, makes a democratic community more interested than other communities have cause to be in **deliberate and systematic education**. The devotion of democracy to education is a familiar fact. The superficial explanation is that a government resting upon popular suffrage cannot be successful unless those who elect and who obey their governors are educated. Since a democratic society repudiates the principle of external authority, it must find a substitute in voluntary disposition and interest; these can be created only by education" [Dewey 1916: 46]. I propose such a big citation to show that the real meaning and role of education in the life of society can hardly be overestimated and it was already mentioned a hundred years ago. Besides, one of the main functions of education is to socialize people, to make the process of incorporating of a person into a society easier and more effective. Moreover, I can claim the state system of education to be one of the most effective methods of socializing [Dewey 1916]. So, if the Aim is to change the World, to make it turn from "consumption fever" to a sustainability, it is not about building new "green" plants and involving the Euro-4, 5,9, etc. standards (though, it doesn't mean that they are useless), it is about the change of peoples thoughts, about fundamental change of world view, it is about re-learning of how to be ecologically effective and environmentally friendly.

## 2. Fields of Education in the Life of a Person

The problem of education has many aspects and I naturally have no opportunity to touch upon all of them. Different countries have their own systems of education which are the results of unique national development, cultural, historical, geographical, and other conditions. Even though nowadays there is a tendency to unify the educational systems of European countries in terms of Bologna process, there are still so many differences between them that it seems to be an idea of extreme complexity. I'm going to analyze educational structure on the basis of the ex-USSR (it refers to a Belorussian and Russian to a certain extent) educational system. So, the educational system in the Republic of Belarus has the pre-school level – kindergartens; the basic school level – schools; gymnasiums, lyceums; the professional education level – vocational and technical institutions; the high education level – universities and academies, and also the level of retraining and further adults' education level – just according to the idea of Life Long Learning (LLL). So, one can see that the process of socialization [Clausen 1968: 5] starts from the very childhood and literary never ends. As far as I'm speaking about the role of education in the life of the modern society let me propose a kind of general scheme which is believed to clarify some points. The proposal is to divide all the process of education in four fields of education (FOE). The main difference between the levels is the main "source of knowledge and motivator" and that is an important matter.

The first FOE starts from the very birth and lasts without changes until the child starts to visit kindergarten or school. So, the main source of knowledge for a person is his family. Parents and relatives are teaching person the basics of the social order and they are a kind of barrier or filter to the stream of information. So the first field of education can be named as "Family field."

The next field we propose to call "institutional field of education" – it is a vast field which contains all the state educational establishments from kindergarten to the university. The characteristic feature of this field is that the educational schedule is determined by the governmental educational standard. For instance in Russia there is a number of educational schedules for kindergartens: "Rainbow," "Development," "Childhood," etc. All schools and of course all universities also have their training programs, so the government decides what people should know in order to be effective in the society. One of the main problems of the state educational standards is that they are rather inert and immobile and it takes ages to feel some changes in the educational system. An important thing is that in the Republic of Belarus, in Russian Federation and to some extent in Ukraine there is

also a compulsory system of qualification training for all people who are engaged in the educational process.

The main source of knowledge here is a class of professionals who are reproducing the present social order and their contribution into the process of socializing is really enormous. The second FOE has a crossing part with the first one, and the influence of the second FOE on the person's life is increasing steadily with the process of person's growing-up. I have to admit that the compulsory nature of the second FOE stimulates people to confront the sources of information to a certain extent.

In parallel with the institutional FOE there is another, I'd say competitive field – the "extra-institutional" FOE. This field consists of any sources of information which are not parts of the state system of education and which propose various types of activities. That can be sports, modeling, music, martial arts, skating, debate club or whatever [Zaki Dib 1988]. The main idea here is that person can choose the source of information on his own (or at least there is an illusion of choice). The third FOE is an important part of human's life and the older person grows the more important this field becomes [Latchem 2014].

The forth FOE can be named as "self-motivated". It is the field where person decides on his own what he needs and what should he do. It means that either the person chooses the proposed "sources of information" or training programs or he or she invents their own. Either way this field is connected not only with maintaining of the existing social order, but it provides the real opportunities to development, to finding new effective ways of building a sustainable society, though, of course, the creativity sometimes brings new problems. So, as far as there is LLL-system so far it has to be used as effective as possible.

## 3. From Ecological Enlightenment to Ecological Culture

Of course I do not deny the effectiveness of green technologies but I presume that they can help us to cope with the consequences of the ecological problems, not with the reasons. Nobody will argue that Nature is a number of complex systems of interaction and so all systems can be classified according to the degree of reciprocation power and their importance to the society and human functioning. That is why we propose it should be: the single object level; the regional or local level; and the global level.

In accordance with the idea of FOE and following the proposed classification of Nature systems I propose to divide the education of sustainable development system (ESD) at 3 Levels [Golubev & Lapina 2015: 101]:

The first level – the level of ecological enlightenment, starts from the first FOE and continues at primary school. This level forms the basic ecological skills and experience and makes the foundation for a future ecologically oriented world view. It's a common knowledge that all of us still keep reproducing a large number of stereotypes we were taught at the kindergarten. It means that we have to form a specific educational schedule for kindergartens and primary school in accordance with the demands of a sustainable society.

The second level – the level of ecological consciousness, grants the basic knowledge of ecological problems and forms in the students the need in ecologically secure environment. This level is the continuation of the first FOE and steadily touches upon the institutional and extra-institutional FOE. It is connected with the educational standards of school and high school levels. Such school subjects as biology, geography, chemistry, health and safety, history can be used in order to form the high level of ecological problems and sustainability understanding. And of course there have to be special school subject "ecology." At this level pupils and students can get acquainted with different types of environmental problems, their causes and methods of overcoming through various activities – both theoretical and practical. Everything depends on a teacher's professional level – and this makes the system of qualification trainings really important.

The third level – the level of ecological culture, is the level when person acquires the appropriate knowledge of how to act according to Nature needs using the logic of sustainable development. It is closely connected with the second and the third FOE but it grants the opportunity to reach the "self-motivation" FOE. People should come to understanding that Nature protection is a part of normal social life which is not less important than economy, ethics or politics.

"Only gradually and with a widening of the area of vision through a growth of social sympathies does thinking develop to include what lies beyond our direct interests: a fact of great significance for education" [Dewey 1916: 77]. So if people are provided with valid environment friendly compendium of knowledge and skills they will be likely to succeed in building of a sustainable society.

## 4. Some Cases of Ecologically Oriented World View Training

I'm going to propose some practical ideas which can be implemented into the educational process at different levels of ESD.

First level is very important because, as we have already mentioned it forms the basis for literary all person's activities in the future. While being in Sweden I get acquainted with the experience of Swedish kindergartens – children are be-

ing taught to sort the rubbish from the earliest childhood. Everybody knows the game – "find the inappropriate subject," so in a form of game children can be taught to sort the rubbish and to understand the importance of rubbish separation for an Environment.

Second level is also important and has a large variety of cases. One can take the "Basket game" example, where pupils collect all their rubbish into a special basket and are analyzing what they are consuming during the day – so, they can see with their eyes their personal level of ecological responsibility. Or there can be a practice of planting trees, collecting of plastic bottles, collecting waste paper or any other kind of activity. For students there can be proposed the debates, writing essays, workshops or making various projects. One group of students proposed to make a big "Ecological Path" which was the war-path of a soviet hero of World War II, a famous in Belarus soviet tank officer Z. Kolobanov. The idea was that the group of students follows his war-path, cleans all the rubbish along this route and plants trees in order to commemorate his heroic deeds.

The third level – is a level of creativity. People usually propose their ideas and projects of how we can make our environment secure. A group of people with a developed ecologically oriented world view made a bunch of small cartoons about the importance of correct warmth preserving in winter time, energy saving, etc. Besides there is a special subject at the quality training and retraining courses – National Strategy for a Sustainable Development. As far as any academic group always consists of professionals from different spheres, the attendees usually analyze their professional parts of a Strategy and then a conference or round tables are being conducted. This usually results in a thesis or scientific articles, and of course all the participants enrich their ecological scope.

So, this is a small amount of examples of ESD, we can admit that there are no limits for creativity and everything depends on our own desire to live in a secure environment.

## 5. Conclusion

Many people know that the Earth Charter "seeks to inspire in all peoples a sense of global interdependence and shared **responsibility** for the well-being of the human family, the greater community of life, and future generations."[1] The author considers ESD to be one of the most appropriate ways of incorporating people into the sustainable social reality through formation of ecological worldview and

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[1]  http://earthcharter.org/discover/the-earth-charter/ [access: 10.12.2016].

through bringing up in modern people the high level of ecological culture and responsibility. However, the conclusions to be drawn from this paper are that:

1. There should be a clear understanding of the fact, that the main ecological problem lies not in the technical level, but in social, and so there should be more ideas of how to change the world view of people. There is need for greater understanding of how to enable the transition from "consumption" world view to ecologically oriented one.

2. Research and evaluation are needed in regard to the fields of education, the role of state system of education.

3. More needs to be done to share and to popularize the practical ideas of how people can apply the ESD in their lives.

## References

Clausen J.A., 1968, *Socialization and Society*, Boston: Little Brown and Co.
Dewey J., 1916, *Democracy And Education*, New York: Macmillan.
Giddens A., 2009, *The Politics of Climate Change*, Cambridge: Polity Press.
Golubev V., Lapina I., 2015, *Perspectives of ecological education in the Republic of Belarus*, International science-practice conference, Witebsk.
http://earthcharter.org/discover/the-earth-charter/ [access: 10.12.2016].
Latchem C., 2014, *Informal Learning and Non-Formal Education for Development*, www.jl4d.info/index.php/ejl4d/article/view/6/6 [access: 10.12.2016].
Luhmann N., 2012, *Theory of Society*, Vol. 1: *Cultural Memory in the Present*, www.amazon.com/Theory-Society-Cultural-Memory-Present/dp/0804739501 [access: 10.12.2016].
Zaki Dib C., 1988, *Formal, Non-Formal and Informal Education: Concepts/Applicability*, http://techne-dib.com.br/downloads/6.pdf [access: 10.12.2016].
www.youtube.com/watch?v=kBlDXQxQbV4 [access: 11.12.2016].
www.youtube.com/watch?v=R344fb93gI8 [access: 11.12.2016].
www.youtube.com/watch?v=ULZ1XPznlbo [access: 11.12.2016].

## Rola edukacji w tworzeniu społeczeństwa zrównoważonego – wybrane aspekty

**Streszczenie.** Tematem niniejszego artykułu są zagadnienia edukacji dla zrównoważonego rozwoju. Zdaniem autora najskuteczniejszym sposobem zmiany sytuacji ekologicznej jest zmiana rzeczywistości społecznej poprzez odpowiednią edukację. Ponieważ strukturalna analiza edukacji może pomóc w lepszym zrozumieniu mechanizmu kształcenia, autor dokonuje podziału procesów edukacyjnych na cztery obszary. Proponuje także wyróżnić trzy poziomy w ramach systemu edukacji dla zrównoważonego rozwoju: oświecenia ekologicznego, świadomości ekolo-

gicznej i kultury ekologicznej oraz podaje przykłady zastosowania ich w edukacji dla zrównowa-
żonego rozwoju.

**Słowa kluczowe:** edukacja, porządek społeczny, zarządzanie społeczne, edukacja dla zrównowa-
żonego rozwoju, obszar kształcenia, oświecenie ekologiczne, świadomość ekologiczna, kultura
ekologiczna

Anna Bernaciak\*, Agnieszka Kozłowska\*\*

# Using Innovative Teaching Methods to Promote Sustainable Development among Students of Economics and Management

**Abstract.** The article discusses main challenges in teaching adults and focuses on selected educational methods viewed as paths for effective learning. We review results of numerous studies conducted by different authors aimed at examining students' educational preferences, needs and expectations. The main objective of the article is to analyse selected methods that can be used in academic settings, such as world café, design thinking, micro-learning or games, and describe ways of applying them in education for sustainable development in faculties of economics and management.

**Keywords:** education for sustainable development (ESD), students, teaching methods

## 1. Introduction

Education for sustainable development is a particularly sensitive area of teaching work. Both the issues taught and the attitude of teachers are often critically evaluated by students. The area of environmental problems and sustainable development frequently become the subject of public (unjustified) criticism, the space for the promotion of pseudoscientific facts, false beliefs, demagogical opinions or the area of political battle [Czaja & Becla 2011; Lippert 2010; Hickel 2015; Janczura 2017]. In practice, it also has a significant impact on people's convictions and attitudes. It relates to the purchasing decisions people make, the habits they

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have and the preferences they declare. The implementation of the teaching process is thus of key importance. Teaching should be based on facts and evidence, which are at the same time referred to everyday life. The aim of education for sustainable development is not only to pass the information [Bernaciak 2016: 36]. It is laborious teaching practice, which should persuade students to modify their attitude. This goal may be accomplished thanks to the presence of a few key factors. They include: teachers' high competence (both professional and methodological), communication, interpersonal and organisational skills, and the awareness of students' needs and expectations as regards the teaching process. Each of these spheres is the subject of interest of different fields, in which a number of proposals are put forward and tools to support teaching are offered.

The aim of this paper is not only to prepare the key methodological accomplishments in the field of teaching adults, but also to discuss the examples of selected teaching methods and their practical application in education for sustainable development. In the first part of the article, we thus undertake to indicate a few areas that influence the academic teacher's work and which pose specific challenges for this profession. The next part is a kind of a repository including the descriptions of teaching methods based on students' activity. They constitute the answer to the question what methods of working with students will address challenges for the academic teacher in the best possible way. The third part discusses case studies which illustrate good practice when it comes to the application of the described methods in education for sustainable development.

## 2. Main challenges
## in the field of teaching adults

In 2009, Professor T. Baumann conducted a survey among academic teachers of the University of Gdansk focusing on their needs as regards teaching skills [Baumann 2011]. Although the author does not find its results to be representative, it may be an inspiration for some reflection. The answers supplied by the respondents (academic teachers with the Master's degree and PhD degree of the University of Gdansk) indicate the lack of awareness how complex the job of an academic teacher is. The research shows that faculty members do not fully realise how complicated the profession of a university lecturer is.

Given the above in mind, a list of areas that are particularly important for building skills needed to teach students has been drawn up, together with their key premises, challenges related to them and the tools they offer. These areas include: andragogy, teaching methodology, students' attitudes, students' preferences, interpersonal competence, neuroscience, educational models, teaching

competence and the labour market. The above list is only a set of elements that are not arranged in a hierarchy. It is also an open list, which may constitute a starting point for further deliberations and research.

As far as andragogy is concerned, Malcolm Knowles observed that one needs to remain vigilant when thinking about adult education. Knowles indicates the difference between the goals that autonomous individual learners set themselves and the goals that an educational institution formulates for them [Knowles, Holton& Swanson 2005: 172]. Outlining new prospects in andragogy, Knowles discusses people's right to search for solutions to the problems they face [Knowles et al. 2005: 173]. Translating it into the language of the academic teacher's everyday work, one should pay attention to the fact that a teacher can make a professional mistake of perceiving students as a homogenous community pursuing the single goal of achieving educational targets established by a university. The academic teacher faces a challenge of confronting a heterogeneous group of learners only a part of whom are deeply interested in the subjects they study and perceive them as a resource desired in life.

Another area, concerning the methodology of teaching, is described by T. Bauman, who "reproaches" academic teachers for understanding and conducting university classes as the unidirectional transfer of logically structured portions of information.[1] What could be an alternative proposal to this way of preparing and teaching classes is a set of the following questions: "what will I teach?," "why will I teach this?," "how will I teach this?," and "how will I know that I succeeded?". Thanks to these questions, academic teachers could develop a habit of reflecting on the nature of their work. What poses the biggest challenge first for institutions employing university teachers is to establish a creative environment that would make it possible to work through the above questions and design classes in accordance with the resulting inspiration.

The area of students' attitudes, in turn, refers to their revealed preferences and their motivation to gain education[2]. The findings of M. Nowak-Paralusz's research show that among factors that motivate students to learn are: the desire to obtain a university diploma, discovering one's life path, fulfilling one's ambitions, and searching for tools that will be useful in one's professional work.[3] Depending on the age group, students' motivation was as follows: the younger the respondent, the lower the awareness of how the studies they have undertaken will prove to be useful in future; the older the respondent, the more aware they are of their own

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[1]  A speech at the scientific-methodological conference at WSB University in Torun held on 29-30 September 2016, entitled *An Achilles' heel of academic teachers*.

[2]  In addition, the motivation to study is not the same motivation for learning a particular subject or attitude, the same attitude is not limited to the motivation. See: Gorard, See and Davies [2012].

[3]  A speech at the scientific-methodological conference at WSB University in Torun held on 29-30 September 2016.

development goals. The academic teacher faces a challenge of taking into consideration the variety of reasons, among which the desire to obtain knowledge provided by a lecturer is not even formulated by the surveyed students themselves. Students at the age of 41 and older emphasise factors such as self-development, ambition and prestige, while younger students (below 25 years of age) perceive studies as the opportunity to find direction in life.

As far as students' preferences are concerned, the abovementioned T. Bauman's research indicates what methods are especially preferred by learners [Bauman 2011: 140]. What they find particularly useful and interesting is work in small groups, trying to solve a problem or accomplish a task they have been given. In the surveys prepared by the researcher, they also marked moderated forum discussions, discussions in small groups and individual work. What students perceived as the least interesting teaching method was the presentation of the subject by a lecturer, although they accepted this form as well. The academic teacher must thus make use of the advantages of all methods in order to achieve particular purposes.

Another area, which refers to interpersonal skills, is connected with the challenge of perceiving the teaching process as a specific human relation. The ability to develop this relation is mentioned by M. Spitzer, who does not indicate any particular skills though, but compares the so-called good teacher (we assume that this also refers to the academic one) to one's beauty, which everyone sees and appreciates, but finds it difficult to define it [Spitzer 2007: 258]. It was the circle of coaches, such as A. Niemczyk [Niemczyk 2012], and psychologists, among others F.S. von Thun [1981], who took an effort to identify and develop interpersonal skills crucial for the job of a teacher of adults. The academic teacher must be aware of the importance of interpersonal relations and of the personal models of designing them and one's educational needs in this respect.

As regards the field of neuroscience, we should mention the issue of attention as defined by D. Goleman [2013].[4] It refers to the concept of the default mode, which is characteristic of the human brain, described by Goleman as an "autopilot". It is contrasted with the intentional thinking, which requires, as the title of his book says, "focus" (concentrating on a given stimulus). Goleman believes that the ability to concentrate is crucial to understand, remember and recognise one's own emotional state and to develop relations. The thesis of concentration as the key to learning is confirmed by the experiments described by Spitzer [Spitzer 2007: 111 ff.]. Spitzer's deliberations allow us to conclude that what is the essence of effective teaching – learning is the environment which stimulates the appropriate areas of the brain to act, which ensures better memorising (learning).

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[4] In this study were presented deliberately chosen clipping area of neuroscience, from which a whole range of issues leading researchers eg. Koch [2004] or Kahneman [2013] describe.

Academic teachers should thus give up verbal presentation, which is a relatively easy form of teaching, and activate students, providing them with the opportunity to focus on selected goals through guided action.

Another area is the field of educational models. The personalised education model as pursued by the universities of Oxford and Cambridge [Czekierda, Fingas & Szala 2015: 255] is also followed in Central and Eastern Europe, including Poland. Collegium Wratislaviense is the centre for training tutors and promotes the idea of tutoring in Polish education (including academic education) [Czekierda et al. 2015: 224]. Coaching, which seeks its pillars in various spheres of science [Rock & Page, 2009], or mentoring, which dates back to ancient times and is very well known in the world of business, are also present in the academic environment (project "Game for the Best" implemented at WSB University in Poznan). Each of these models, based on the conviction that participants of the educational process should be treated individually, requires a range of specific competences (knowledge, skills and behaviours). Academic teachers face the challenge of obtaining awareness of how many different forms of the educational process there are – and thus – how important it is to revise one's own teaching competence in the light of this diversity.

The next area refers to teachers' didactic competence. Bauman points out that competence gaps in the academic teacher's skills are an Achilles' heel of the whole higher education in Poland. Analysing the results of her research, she depicts the profile of a lecturer, who – when it comes to his or her own professional competence – is dangerously inclined to cognitive optimism, which is undesired in academic circles. It means that, being unaware of their own incompetence, academic teachers rank themselves highly or very highly as professionals [Bauman 2011: 28]. This conclusion helps us to identify another challenge for academic teachers: a call for humbleness regarding their didactic knowledge, a desire to establish its level and motivation for formal self-development.

The last area relates to students' activity undertaken after completing the educational process (or increasingly often during its course). This area is related to the labour market. This is where the needs and skills of graduates prepared by teachers in the teaching process (demand side) clash with the needs and offer of employers (supply side). On 23 April 2012, "Gazeta Wyborcza," a Polish newspaper, published the open letter of the then chairman of the insurance company PZU, Andrzej Klesyk, in which he criticised university graduates' inability to think independently [Klesyk 2012]. This opinion is shared by other employers, who expect Polish universities to train professionals that will have specific competences needed in the labour market. According to the unofficial report of Wavin Poland, businesses seek capabilities such as the ability to present data in an interesting way (storytelling), the selection and maintenance of communication channels, IT skills, prioritising, task management, critical thinking and problem

solving.[5] Therefore, academic teachers should be aware of these expectations and should design their classes in a way that would allow students to practise skills sought in the labour market as often as possible. Given the above considerations, we may conclude that inadequate teaching skills might make it difficult or even impossible to select the right teaching methods.

## 3. Selected teaching methods as the components of the effective didactic process

The determinants of the academic teacher's work addressed in the first part of the paper provoke reflection on what methods of working with students will match the needs of adult learners and at the same time meet the challenges of the outside world. Therefore, we purposefully selected the teaching methods that are briefly discussed below. What they all have in common is the fact that they allow learners to act, which results from all the determinants described earlier. Whether they are the concepts of andragogy, the study of students' behaviour, or labour market expectations – each of these methods involves, to a different degree, encouraging students to build their knowledge or practise a skill through their own action. The methods we selected include: brainstorming, world café, design thinking, peer learning, microlearning, games.

The first method is **brainstorming** [Osborn 1953; Jablin & Seibold 1978]. Our experience shows that it is often confused with an academic discussion or a conversational lecture. The classic brainstorming session consists of at least three stages. All of them are necessary if the final decision is to be made and the plan of action is to be outlined at the end of the meeting. For the sake of classes with students it is enough to conduct only the first phase – the stage of generating ideas. The teacher acts as the moderator; he or she formulates a problem (e.g. in the form of an open question) and encourages students to come up with all kinds of solutions, whether they are possible or impossible to implement. Any solutions and any ideas are welcome in this method. What the moderator may find the most difficult part is to refrain from commenting. The participants, in turn, cannot claim the authorship of an idea as it is assumed that all members of the group work together to work out their joint solution. Trying to prompt the

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[5] The summary of the report presented on 17 November 2016 at the lecture entitled *The role of shared services centres in shaping future finance sector specialists in the labour market in Poznan*, in the office of Wavin Poland S.A. (version available in the Bureau of Careers and Internships at WSB University in Poznan).

students to make new suggestions, the teacher may use simple questions, such as: What else? What should there be less of? What should there be more of? What instead? What if…? At the second stage of a brainstorming meeting, the lecturer is still the moderator, but this time he or she proposes the criteria for the evaluation of ideas and helps to arrange them in order. At the third stage, the teacher is the decision-maker since he or she chooses a person that will implement the idea generated by the whole group. The planning and implementation stages will be more likely to be conducted in enterprises than at university classes, thus we suggested that only the first phase should be practised with students.

The **world café** method serves the purpose of building collective wisdom, sharing knowledge, exchanging ideas and working out concepts [Brown & Isaacs 2005]. It makes the whole group and each participant individually involved. It consists in laying out the classroom to make it look like a café, with tables as workstations among which the teams of participants move when they are instructed to do so. Each table has its host, who introduces the subject, animates the discussion and summarises the main points. The time limit for one team is 10 minutes at one table, after which each team moves to another table. The host puts the team members in the picture and encourages them to add new threads, create and record ideas, and develop the recorded concepts. When all teams go through all stages, the hosts present the results of collective work, followed by a discussion on the adopted solutions.[6]

The next method – **design thinking** is the most complex one.[7] It originates from Stanford University and although it is used in management and engineering, it is also an interesting tool applicable in the educational process. It consists of a series of consecutive elements of the process which should lead to finding a group solution to the problem or generating a creative idea. It involves the following stages: *empathising, defining, ideating, prototyping and testing*. Its application in an interdisciplinary group (students of different majors or specialisations) brings a number of added benefits, related to transferring ideas, confronting different viewpoints and ways of perceiving problems.

The **peer learning** method follows a similar principle [Boud, Cohen & Sampson 2014; Boud 1999]. It is based on contacts between peers or people of a similar age or social status. It departs from the teacher-student relation, focusing on sharing knowledge in one's own environment. It is founded on the assumption that each of the participants of the teaching process, especially adult learners, has

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[6] The teacher should put some writing materials on the "tables". In the original version, the whole table is covered with a paper cloth, on which the participants can freely write down or even draw their ideas.

[7] Application possibilities and a detailed description of its stages are discussed in a number of practical publications. One of the more interesting works is the book by Plattner, Mainel and Leifer [2013].

a specific store of content-related knowledge, experience or formulated opinions. Friendly peer surrounding is conducive to sharing this store with others. Students are given time to discuss a problem by exchanging their own experiences.

The peer learning method may be supplemented by **microlearning**. It consists in providing students with small portions of content, so called "learning pills", which they are given not only during classes. The application of available technologies makes it possible to create educational mementos. Microlearning tends towards push technology through push media, which reduces the cognitive load on the learners. Practical applications of this technique together with explanations are discussed by, among others, S. Mosel [2005] and E. Masie [2006], as well as by T. Hug [2007] in the first book about this method.

The last of the presented methods is the **educational game**. Its popularity is connected with the dissemination of technology and an increasingly wide choice of games (e.g. the latest playbook by Sweeney, Mehers & Meadows 2016). Among the most popular types of games used at classes for students are virtual games combining decision-making games and role playing games. Playing them, students act in a virtual world, based on real relationships and regularities, in which they assume specific roles. Their effectiveness thus relies on the arrangement of a friendly learning environment. Their internal motivation is stimulated; students become goal-oriented and are encouraged to interact and get emotionally engaged [Bernaciak & Brańka 2015].

The presented methods do not represent the whole catalogue of available teaching tools to be applied in the educational process. We believe, however, that their specific nature meets students' expectations and the related didactic challenges on the one hand, and, on the other hand, enables the implementation of the assumptions of education for sustainable development.

## 4. The practical application of the selected teaching methods for the promotion of sustainable development issues

In the Polish academic reality, the areas of sustainable development or climate change are not considered to be separate fields of study. They are not obligatory at the studies in management or economics, either. It seems, however, that regardless of the formal curriculum of subjects, these issues can be implemented at almost any kind of university classes. The application of the teaching methods described above improves the efficiency of their implementation and makes it possible to affect attitudes and beliefs. Although it is a lengthy and not always

successful process, the aim of education for sustainable development is not only to pass knowledge, but also to work on students' attitudes, for example, through stimulating reflection. Below we present the specific examples of the practical application of the particular teaching methods in the studies of economics and management. They are based on our professional experience and may become an inspiration for those wishing to undertake their own teaching "experiments."

The first of the methods we discussed – brainstorming - meets students' need to work in groups in order to solve a problem. It is thus extremely important to remember that the teacher should act as the moderator. He or she should not interfere with the sphere of idea generation, but can only develop the consecutive stages of the analysis by asking supporting questions and providing additional information. If this method is used for teaching subjects not related to sustainable development, it may add a broader perspective to the issues under analysis. When pointing at the possible solutions of a particular case, students may also evaluate the formulated proposals – by assessing their social or environmental consequences, indicating the ways of risk mitigation, or varianting solutions in the context of saving resources. The search for non-standard solutions, the collective generation of ideas and the positive effects of group work may lead to interesting proposals. It is also possible to stage the application of this method. In the first part, students seek solutions, according with the boundary conditions specified by the teacher, while in the second one – these solutions become subject to critical evaluation from the angle of their social or environmental context. This is particularly important at business universities, where economic efficiency, profitability or low costs are the dominant criteria. An alternative look at these issues may give rise to further studies in the area of sustainable development.

When the next method – world café – is used, the value-added concerns interpersonal competences and the application of positive effects of changing the learning environment (the field of neuroscience). It often happens that the layout of space itself – a friendly room with a few tables with chairs, suitable for holding informal meetings – may stimulate and encourage students. What may be an interesting thing to do is to combine this method with a quasi role playing game, in which the particular groups of participants represent different interest groups (stakeholders) and analyse the situation from the angle of their needs and expectations. It helps to distinguish different viewpoints, as well as different interests and desires of each participant of the decision-making process. Vacancies in city centres and proposals concerning their efficient development may serve as a good example of an issue to be evaluated. In this case, the stakeholders will include: local authorities, investors, city residents, the homeless.

The design thinking method is mostly dedicated to project-based classes and should be implemented in a complex, purposeful and organised way. Its methodology is thoroughly discussed in the literature and what is its benefit is the fact

that it is applicable in interdisciplinary groups. It makes it possible for students to obtain competences that are valuable from the point of view of a potential employer and to develop interpersonal and communicative skills. The traditional educational model is thus modified. This method is also more effective owing to students' emotional engagement in the problem and a sense of having actual influence on reality (if this is possible). Therefore, it is recommended that local authorities or social organisations should be contacted so that students could face real problems demanding instant solutions. The examples include issues of property development, social inclusion, local investment projects and programmes, social participation, etc. The more related to the participants' daily activity a given issue is, the more involved they become.

The use of the peer learning method, just like in the case of brainstorming, requires the minimisation of the teacher's participation. At the same time, it is a kind of challenge, because its aim is to create conditions for students to share acquired knowledge, which is not always effective or may not even be possible (students have neither knowledge nor experience in this area). From the point of view of education for sustainable development, this method may be effectively used, though. It helps to verify stereotypes and widely-held beliefs which may be rooted in the learners' minds. It is the issues of climate changes or alternative energy sources that are vulnerable to this kind of incompetence. By making such issues the topic of discussion we create the foundation for formulating solutions based on students' knowledge, which is gradually verified by the teacher through information, data and source documents he or she provides. It is also recommended that students are given materials presenting different viewpoints before classes, and then encouraged to share the knowledge they have acquired and reach consensuses.

Microlearning is a tool that may support all the above forms of teaching classes. In order to use it effectively, the teacher must increase his or her involvement outside working hours. However, it is an efficient tool, which fits in the modern communication model. To maintain the real contact with students and spread certain opinions or beliefs among them, it is worth using the same communication channels as your students use. The classes are by no means traditional lectures based on the lecturer-listener relation. As the research results presented above show, young people do not prefer this kind of communication. The use of community sites (Facebook), micro-communication channels (Twitter), non-standard tools of information transfer (Instagram, Snapchat) or any other channels of virtual communication (internet websites, blogs, microblogs, videoblogs) allows teachers to enter the world in which their students spend a lot of their time. This requires specific forms of communication, which are more accessible for them (short announcements, visual messages, etc.). Such forms also make it

easier to use everyday situations for passing general ideas connected with sustainable development.

The last of the tools under discussion is the most diverse and complex one. The use of games for teaching, apart from a number of benefits discussed in the literature quoted before, allows illustrating relationships that occur in the real world in a simplified and indirect manner. Games make their participants cooperate effectively in a group; they teach them to make decisions and test their effects in the safe conditions of virtual reality, as well as additionally engaging players, introducing the element of emotional involvement. In case it is not possible to use a specific teaching game, teachers can create such on their own. The simplification of the described phenomena, the attempt to use simple tools (paper, scissors, coloured markers), and the introduction of the element of rivalry, all help to create short game-based teaching activities, which may make classes significantly more attractive. These games may directly refer to the issues of sustainable development, but they might also be used for teaching subjects in the field of management. By carrying out the decision analysis, the evaluation of the results of the adopted solutions or different kinds of effects, students can assess the efficiency of the implemented strategy in a broader context.

## 5. Conclusion

Education for sustainable development is a complex activity and involves a number of challenges. In order to use it effectively, teachers must constantly broaden their knowledge, increase their involvement and show courage. The inclusion of sustainable development problems in the content of other classes seems to be essential for the completeness of the educational process, not only regarding knowledge, but also social competence and behaviour. The issues addressed in this paper contribute to and stimulate the reflection on the daily teaching practice of academic lecturers. The methods we discussed represent only a part of methodological skills, which should be improved on a regular basis. A question arises whether teachers themselves should undergo additional training in the implementation of environmental content in their everyday practice. Only focused and consistent action in this respect can influence young people's perception of the environmental challenges of the contemporary world.

## References

Bauman T., 2011, *Proces kształcenia w uniwersytecie w perspektywie potrzeb nauczycieli akademickich i oczekiwań studentów. Research report*, Gdansk: Wyd. UG.

Bernaciak A., 2016, The Role of Local Authorities in Education for Sustainable Development in Poland, *Studia Periegetica*, 1(15), 35-44.

Bernaciak A., Brańka T., 2015, Gra jako narzędzie dydaktyczne w kształceniu na poziomie akademickim. „Park Manager Game", *Studia Oeconomica Posnaniensia*, 5,159-174.

Boud D., 1999, Situating academic development in professional work: Using peer learning. *The International Journal for Academic Development*, 4(1), 3-10.

Boud D., Cohen R., Sampson J. (eds.), 2014, *Peer learning in higher education: Learning from and with each other*. New York: Routledge.

Brown J., Isaacs D., 2005, *The World Café: Shaping Our Futures Through Conversations That Matter*, San Francisco: Berrett-Koehler Publishers.

Czaja S., Becla A., 2011, *Czterech jeźdźców ekologicznej zagłady we współczesnym świecie*, in: *Trendy i wyzwania zrównoważonego rozwoju. Księga jubileuszowa dedykowana Profesorowi Marianowi Malickiemu*, ed. B. Kryk, Szczecin: Wyd. USz.

Czekierda P., Fingas B., Szala M. (eds.), 2015, *Tutoring. Teoria, praktyka, studia przypadków*, Warsaw: Wolters Kluwer Polska.

Goleman D., 2013, *Focus: The Hidden Driver of Excellence*, Bloomsbury: Harper Collins.

Gorard S., See B.H., Davies P., 2012, *The impact of attitudes and aspirations on educational attainment and participation,* www.jrf.org.uk [access: 8.02.2017].

Hickel J., 2015, *The Problem with Saving the World. The UN's new Sustainable Development Goals aim to save the world without transforming it*, www.jacobinmag.com/ [access: 8.02.2017].

Hug T. (ed.), 2007, *Didactics of Microlearning. Concepts, Discourses and Examples*, Münster – New York – Munich – Berlin: Waxmann.

Jablin F.M., Seibold D.R., 1978, Implications for problem-solving groups of empirical research on 'brainstorming': A critical review of the literature, *Southern Speech Communication Journal*, 43(4), 327-356.

Janczura M., 2017, *Minister zdrowia ostrzega: „Część Polaków ciągle pali". A smog? „To zagrożenie troszkę bardziej teoretyczne*, www.tokfm.pl/ [access: 8.02.2017].

Kahnemann D., 2013, *Thinking, Fast and Slow*, New York: Farrar, Straus and Giroux.

Klesyk A., 2012, *Prezes PZU: Szukamy tych, którzy myślą samodzielnie*, http://wyborcza.pl/ [access: 12.12.2016].

Knowles M., Holton III E.F., Swanson R.A., 2005, *The Adult Learner. The Definitive Classics in Adult Education and Human Resource Development*, Amsterdam: Elsevier Butterworth Heinemann.

Koch Ch., 2004, *The Quest for Consciousness: a Neurobiological Approach*, Engelwood: Roberts and Co.

Lippert I., 2010, *Fragments of Environmental Management Studies*, Tönning – Lübeck – Marburg: Der Andere Verlag.

Masie E., 2006, *Nano-Learning: Miniaturization of Design*, www.cedma-europe.org/ [access: 17.12.2016].

Mosel S., 2005, *Self Directed Learning with Personal Publishing and Microcontent. Constructivist Approach and Insights for Institutional Implementations*, Paper presented at the

Microlearning 2005 conference, June 23-24, 2005, Innsbruck, Austria, www.semanticscholar.org/ [access: 17.12.2016].

Niemczyk A., 2012, *Trener skuteczny. Procedury dla prowadzących szkolenia*, Warsaw: Difin.

Osborn A.F.,1953, *Applied imagination: Principles and Procedures of Creative Problem-Solving*, Oxford: Charles Scribner's Sons.

Plattner H., Meinel Ch., Leifer L., 2013, *Design Thinking. Understand – Improve – Apply*, Berlin: Springer.

Rock D., Page L.J., 2009, *Coaching with the Brain in Mind. Foundation for Practice*, New Jersey: John Wiley & Sons.

Spitzer M., 2007, *Learning: The Human Brain and the School of Life*, Amsterdam: Elsevier Butterworth Heinemann.

Sweeney L.B., Mehers G.M., Meadows D., 2016, *The Climate Change Playbook. 22 Systems Thinking Games for More Effective Communication about Climate Change*, Chelsea: Green Publishing, Vermont: White River Junction.

Thun F.S. von, 1981, *Miteinander reden: Störungen und Klärungen. Psychologie der zwischenmenschlichen Kommunikation*, Reinbek: Rowohlt.

## Wykorzystanie innowacyjnych metod nauczania w popularyzacji zagadnień zrównoważonego rozwoju wśród studentów (na kierunkach ekonomia i zarządzanie)

**Streszczenie.** W artykule przedstawiono główne wyzwania w nauczaniu dorosłych, kładąc nacisk na wybrane metody nauczania. Dokonano ich opisu na podstawie źródeł literaturowych oraz ukazano możliwości ich zastosowania w edukacji na rzecz zrównoważonego rozwoju, opierając się na praktyce dydaktycznej autorek. Ponadto przedstawiono wyniki badań prowadzonych przez różnych badaczy na polskich uczelniach, odnoszących się do oczekiwań, preferencji i potrzeb studentów w zakresie procesu dydaktycznego i jego efektów. Sprostanie zgłaszanym potrzebom wymaga od prowadzących zajęcia szczególnej uwagi i świadomego zaangażowania. Głównym celem opracowania jest omówienie wybranych metod nauczania, takich jak: *world café*, *design thinking*, *microlearning* czy gry dydaktyczne, oraz przedstawienie propozycji ich praktycznego zastosowania w edukacji na rzecz zrównoważonego rozwoju, przede wszystkim wśród studentów kierunków ekonomii i zarządzania.

**Słowa kluczowe:** edukacja na rzecz zrównoważonego rozwoju, studenci, metody nauczania

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# The Use of Memberwise Disjunction Mechanism to Select Teaching Methods Depending on Student Personality Type

**Abstract**. The problem of teaching methods classification doesn't lose its importance nowadays, because it gives the opportunity to analyze each method potential and to identify ways for its improvement, further development and implementation. A large number of approaches to teaching methods classification exists due to the complexity of the study object and seriousness of the tasks set by society before the modern professional school. The use of the memberwise disjunction mechanism in training methods classification which allows to take to the account wider range of different teaching methods symptoms is proposed. Visualization of the proposed classification with the help of graphs preserves the informational content of the multivariate data in a convenient, human-readable form, simplifies the perception of such classification and focuses attention on its features. Depending on the objectives of effective learning provision, it is possible to change the dominant criteria, and accordingly choose an effective, in this case, teaching methods. In the given example, a logical connection between teaching methods and students' types of consciousness and thinking is shown.

**Keywords:** teaching methods classification, memberwise disjunctions mechanism, graphs, visualization, thinking structure, consciousness types

## 1. Introduction

The problem of teaching methods was studied by number of eminent scientists both in Ukraine and abroad. In particular, states that "there is still no more impor-

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tant category for the development of educational theory and educational practice than the category of "teaching method" in pedagogy". The method describes the activity from the standpoint of the process, the method – procedural activity characteristics. But not every process is method. Method acting normative activity process model, determines the most efficient and optimal way in solving relevant problems" [Slsatenin et al. 2002: 270].

The teaching method – extremely complex and polysemantic concept. "One cannot achieve the goal, realize the planned content, fill the teaching with cognitive activity without methods. Method – is a core of educational process, connecting link between the designed purpose and end result. Its role in "goal – content – methods – forms – learning tool" is crucial [Podlasyj 2003: 470].

The choice of teaching method to the appropriate method of students' thinking will increase the educational process efficiency.

## 2. Research and publications analysis on teaching methods classification

Scientists have not yet come to a common understanding of the term "method", naturally, there is no single classification. Due to the complexity and seriousness of the research object tasks assigned by society to modern vocational school a large number of approaches to teaching methods classification exists. Therefore, assessing all approaches to the teaching methods classification in general, it should be noted, that quest offers many didactists and trainers to use in training information methods and along with them use other as well, enabling "loosen the soil" of the human mind, today can be considered correct and necessary. These searches are aimed to stimulate the functionality of passive knowledge, turning them into active and to facilitate the assimilation of new knowledge and their application in practice.[1]

Works of native didactists Alexander Alexuk [1981] and Vladimir Onishchuk [1987] are still popular now. They consider different approaches to teaching methods classifications, chronologically analyze their development.

Yurij Babanskiy [1985] proposed a universal classification, designed for all learning situations. Its methodological basis – is a holistic action approach. It incorporates the classifications, taking into account the motivation, sources of knowledge, learning form, learning logic, control and self-control. Alltogether, this is the most constructive classification, but it needs to be improved because it does not include system-structural methods, that ignores the logical structure of educational material and doesn't show main groups of methods subordination. In

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[1] *Metody obuchenia*, http://vaniorolap.narod.ru/theme11.html [access: 15.12.2016].

advanced classification four groups of methods are included, composed according to their generalization, depending on the target functionality of each group. The largest group is the methods of teaching and learning activities organization.

Vladimir Sydorenko [2006: 21] offers his approach to building training methods (and tools) classification. It is based on content and form categories ratio. Sydorenko proposed classification scheme, which can be considered as a basis for teaching methods normative system, specific nomenclature which is used for building and implementing organizational learning forms according to his purpose. This author gives a summary of qualitative characteristics (nature, system, ways to improve) teaching methods, which complements and refines existing notions of this fundamental didactic concepts.

There are other classifications of teaching methods – Ivana Pidlasoho [2003], Mihaila Makhmutova [1986] (teaching methods and learning methods), Viktoria Kunicina [2001] (which combine two forms of logical methods – analysis and synthesis, analysis and induction, synthesis and induction, synthesis and deduction), Olga Zheleznyakova [2006: 46-54] (an innovative approach to the classification and the choice of teaching methods) and others.

Currently there is no single methods essence interpretation as educational category. Translated from the Greek "methodos" means "the way of research, theory," a way to achieve a goal or perform a specific task. Etymologically, it is associated with a value that the methodology or the method of investigation has, the search for truth. But often it is associated with the method of presentation that basically changes and simplifies the content of any training that leads to a misunderstanding of the things essence. In pedagogy the disclosure of teaching methods and their classification is still controversial.

The article offers a new way of teaching methods classifying with the use of term by term disjunction. This new approach will allow the classification to consider a wider range of different teaching methods features, for example, choose an effective method depending on the consciousness type and student thinking structure. It is possible to select individually for each student the most effective teaching method not only in Higher Education but in farther sustainable education during his life as well.

## 3. The use of memberwise disjunctions mechanism for teaching methods classification

Systematization of major known teaching methods is given in Table. 1. Methods systematization contains different set of characteristics that describe their respective categories and are called subjects. Subjects define characteristics weight and

Table 1. Main Teaching Methods Characteristics

| No. | Method | Content | Student activity | Student mental activity level | Knowledge level | For the level of inclusion into creative activity | For the domain mode of content transmission | Student activity level |
|---|---|---|---|---|---|---|---|---|
| 1. | l1 Lecture, briefing | Forming a learning circle | Passively acquire knowledge | r1 Recognition | Acquaintance | u1 Information receptive | Auditory | Passive |
| 2. | l2 Work with a book | | | | | | Visual | Passive |
| 3. | l3 Conversation, dialogue, discussion | Knowledge synchronization between the parties | Actively acquire knowledge | r2 Reproduction | Copying | u3 Problem exposition | Auditory | Semi-active |
| 4. | l4 Training | Given knowledge snap to proper use | Develop practical skills | r3 Usage | Skills | | Kinesthetic | Active |
| 5. | l5 Educational, business, didactical games | | | | | | Kinesthetic | Active |
| 6. | l6 Algorithmic presentation of task | | | | | u2 Reproductive | Kinesthetic | Semi-active |
| 7. | l7 Practical laboratory work | | | | | | Kinesthetic | Semi-active |
| 8. | l8 Method of control questions | Specification of acquired knowledge in relevant situations | Ability to use skills in specific situations | | Expanding ability | | Auditory | Semi-active |
| 9. | l9 Situation modelling | | | | Supplement | u4 Heuristic | Auditory | Active |
| 10. | l10 Heuristic search, brainstorming, round table | Given knowledge snap to untypical situations, their interpretation | Actively summarize and transform acquired knowledge | r4 Creativity | Transformation | | Auditory | Active |
| 11. | l11 Design and survey work | | | | | u5 Researching | Kinesthetic | Active |

Source: own elaboration.

can be placed in a linear row by ascending or descending characteristics weight values. Teaching methods classification is usually made intuitively, the sequence of it is a number of systematization mistakes and descending characteristic weight values selection. That is why it is reasonable to fulfill strict and clear classification algorithm based on mathematical conception.

Memberwise disjunctions method will be used for this purpose. The essence of this method lies in the systematized element selection, which have common features and qualities, is regrouped according to the selected criteria on certain algorithm. As the result certain elements structure is created. Assigning new criterion, we will get another structure, which shows element interdependence regarding this criterion.

We write the "Signs set" as $R = \{ri\}$, which has 4 items – signs set value, i.e $i = 1,..., 3, 4$, where $r1$ = recognition; $r2$ = reproduction; $r3$ = usage; $r4$ = creativity. The set "Signs" $U = \{ui\}$ has 5 items – signs value, i.e. $i = 1,..., 5$, where $u1$ = information receptive level; $u2$ = reproductive level; $u3$ = problem exposition level; $u4$ = heuristic level; $u5$ = research level. Set "Signs characteristics" $L = \{l\}$ has 11 pieces – signs values, that is $i = 1,... 1$, where $l1$ = lecture, briefing; $l2$ = work with a book; $l3$ = conversation, dialogue, discussion; $l4$ = training; $l5$ = educational, business, didactical games, $l6$ = algorithmic presentation of task accomplishment; $l7$ = practical laboratory work; $l8$ = method of control questions; $l9$ = situation modelling; $l10$ = heuristic search, brainstorming, round table; $l11$ = design and survey work. Introduce outlined set $Q = \{qi\}$ signs areas $qi$, $i = 1,..., 1$, that is:

$$Q = \{qi\}, i = 1,..., 1.$$

We can build a paradigmatic table that reflects the relationship between the signs localization area $qi$ and subject variables $l, u, r$ (Table. 2).

Table 2. Relationship between Signs Localization Area $qi$ and Subject Variables $l, u, r$

| Signs set | Signs | Signs characteristics | Signs localization area |
|---|---|---|---|
| $r1$ | $u1$ | $l1$ | $q1 = r1u1l1$ |
| $r1$ | $u1$ | $l2$ | $q2 = r1u1l2$ |
| $r2$ | $u3$ | $l3$ | $q3 = r2u3l3$ |
| $r3$ | $u2$ | $l6$ | $q4 = r3u2l6$ |
| $r3$ | $u2$ | $l7$ | $q5 = r3u2l7$ |
| $r3$ | $u2$ | $l8$ | $q6 = r3u2l8$ |
| $r3$ | $u3$ | $l4$ | $q7 = r3u3l4$ |
| $r3$ | $u3$ | $l5$ | $q8 = r3u3l5$ |
| $r3$ | $u4$ | $l9$ | $q9 = r3u4l9$ |
| $r4$ | $u4$ | $l10$ | $q10 = r4u4l10$ |
| $r4$ | $u5$ | $l11$ | $q11 = r4u5l11$ |

Source: own elaboration.

The description of the meaning is needed. For example, signs localization area $q1 = r1u1l1$ = recognition information receptive level lecture, briefing: level of student's mental activity as recognition refers to information receptive level of creative activities can be implemented by instruction or lectures methods. $q11 = r2u3l3$ = reproduction level of problem presentation conversation, dialogue, discussion: the level of student's mental activity as reproduction refers to the problem presentation of creative activity and can be implemented in conversation, dialogue, discussion.

Signs localization area $q$ is expressed through the value of subject variables $r$, $l$, $u$ as follows:

$r1u1l1 = q1; r1u1l2 = q2; r2u3l3 = q3; r3u2l6 = q4; r3u2l7 = q5; r3u2l8 = q6;$
$r3u3l4 = q7; r1u3l5 = q8; r3u4l9 = q9; r4u4l10 = q10; r4u5l11 = q11.$

Performs term by term disjunction the greatest possible number of related equations [Zinko 2015]. Introduction of term by term disjunction using a related equity due to the need to obtain local areas characteristics. Such areas may include more than one calculated limited number of signs and domains of research.

$r1u1(l1 \vee l1) = q1 \vee q2; r2u3l3 = q3; r3u2(l6 \vee l7 \vee l8) = q4 \vee q5 \vee q6;$
$r3u3(l4 \vee l5) = q7 \vee q8; r3u4l9 = q9; r4u4l10 = q10; r4u5l11 = q11.$

We form the function of transmission from sign subject's area $q$ to the classification sign local area $m$. That is from the sign common amount into domain amount determine the signs, which can be characterized according to the criterion, for example, student's activity level.

$$q1 \vee q2 = m1; q3 \vee q6 \vee q7 \vee q8 \vee q6 = m2; q6 \vee q5 \vee q9 \vee q10 \vee q11 = m3 \qquad (1)$$

Taking to the account the dependence of domains signs $q$ on the subject variables $r$, $l$, $u$, and the relationship between signs subject areas $q$ and signs local area classifications $m$ (1), dependence of local areas $m$ on subject variables $r$, $l$, $u$ are as follows:

$m1 = r1u1(l1 \vee l2); m2 = r2u3l3 \vee r3u2l8 \vee r3u3(l4 \vee l5)$
$m3 = r3u2(l6 \vee l7) \vee r3u4l9 \vee r4u4l10 \vee r4u5l11.$

Predicate $P(r, l, u, m)$ depict the classification relationships between the training methods is as follows:

$P(r, l, u, m) = m1r1u1(l1 \vee l2) \vee m2r2u3l3 \vee m2r3u2l8 \vee m2r3u3(l3 \vee l5) \vee$
$\vee m3r3u2(l6 \vee l7) \vee m3r3u4l9 \vee m3r4u4l10 \vee m3r4u5l11$

The rapid growth of heterogeneous information requires a search for new ways of their compact presentation. One of the important approaches is visualization that is the mode of data presentation in a two-dimensional or three-dimensional moving and fixed images. Most part of the information that is available

for humans cannot be represented in two- or three-dimensional form without losses. Therefore, it is important to solve the problem of reducing these losses, i.e. the preservation of informativity in the construction of multi-dimensional data to a convenient for human perception form.

The predicate $P$ can be visually represented as a graph (Figure 1). Graphic representation shows that teaching methods by the student's activity level criterion can be represented in a form of three-pole graph. Poles correspond to the student's activity level: passive $m1$, semi-active $m2$, active $m3$. By the student mental activity level dominate methods of usage $r3$, creativity $r4$ in the pole $m3$. According to the dominated in the pole $m2$ by the student mental activity level is the usage level $r3$, and by the inclusion into the creative activity level – reproductive $u2$.
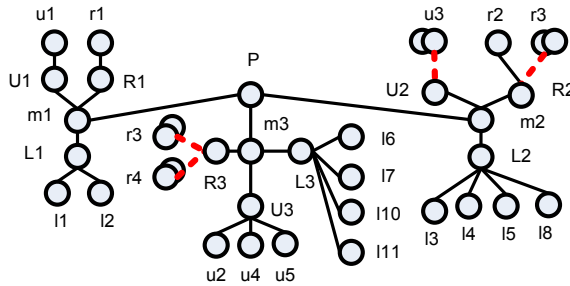


Figure 1. Classification of teaching methods by the student's activity level criterion.

Source: own elaboration.

If to form the function of the transition from domain knowledge area $q$ to sign classification local area $m$ on the other criterion, for example, on the domain mode of content transition, then the local area $m$ will be as follows:

$$q1 \vee q3 \vee q8 \vee q9 \vee q10 = m1; \quad q2 = m2; \quad q4 \vee q5 \vee q6 \vee q7 \vee q11 = m3 \qquad (2)$$

Predicate $P(r, l, u, m)$ taking to the account the signs (2) as follows (Figure 2):

$$P(r, l, u, m) = m1r1u1l1 \vee m1r2u3l3 \vee m1r1u3l5 \vee m1r3u4l9 \vee m1r41u4l10 \vee$$
$$\vee m2r1u1l2 \vee m3r3u2(l1 \vee l7 \vee l8) \vee m3r3u3l4 \vee m3r4u5l11$$

So teaching methods based on the mode of transmission of content divided into three options: auditory $m1$, visual $m2$, kinesthetic $m3$ (Figure 2). Accordingly, the structure of the graph with three poles is formed. As an additional example of this is the classification by the student mental activity level and classification by the inclusion into creative activities level.

It is seen from the graph, that in variant $m1$ methods of recognition are used more frequently $r1$, in variant $m3$ methods of usage $r3$ and reproduction $u2$.
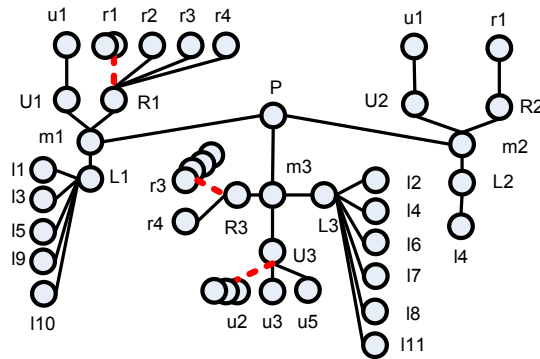
Figure 2. Classification of teaching methods by the dominant mode of content transition criterion

Source: own elaboration.

# 4. The students' type of consciousness and pedagogical forms of influence are on it using teaching methods classification

We show the relationship between selected dominant criteria for methods classification and components of the educational process is shown. That is to select the most effective teaching method according to such criterions as students' type of consciousness, temper, dominating information processing etc.

Some didactists and authors of textbooks [Babanskij 1985; Mahmutov 1986; Rzeleznjakova 2006: 46-54] propose criteria that should guide the choice of teaching methods. So the choice of teaching methods will be determined:

1. Laws and principles of teaching.
2. The objectives and tasks.
3. The content and methods of science in general and specific subject, topic.
4. Students learning opportunities:
    a) age (physical, mental);
    b) the level of preparedness (education and upbringing);
    c) the student community peculiarities;

The external environment features (geographical, industrial environment, etc.).

Opportunities teachers themselves: their previous experience, knowledge of typical learning process situations, which are the most effective some methods combination, the level of theoretical and practical grounding, the ability to use

certain methods, tools, the ability to choose the best option, personal qualities and others.

Students educational opportunities significantly affect the quality of the learning process. Student learning capabilities and student's type of consciousness are important as well.

The learning capability of the audience should be taken into consideration as well. In general, the features of learning capability are considered as the following:

– activity – the ability of orientation in the new environment;
– creative activity – transferring of the known solving problems methods into new conditions;
– mental activity – the velocity of new concepts and modes of life creation;
– pace, thrift (the amount of material on which the problem is solved, the number of steps), performance, endurance;
– susceptibility to help another person, which can be measured by the number of dosed assistance, necessary for the student to complete the task.

The learning process for different types of consciousness should contain elements of belief that requires the ability to handle arguments and counterarguments, considering the position that is taught, from different angles, including the possible disagreement and resistance of those who are influenced by new arguments [Kunicina et al. 2001]. Unreliable but subjectively convincing information can sometimes be used as arguments.

When we speak about reasoning, the question inevitably arises: in what cases should we represent only our view and our arguments in one-sided manner and when it might turn out to be more successful to provide simultaneous usage and arguments of the opposite side.

In other words, if you have decided to hold a class discussion about the dangers of industry air emissions, then is it enough to point out the negative consequences such as a variety of serious diseases or it would be more appropriate to discuss the arguments of proponents as well (the damage of the emissions is less than derived products, it helps to create new materials – then the process will be improved and emissions will be reduced, etc.) and decide together what is more important? The first option of offering the information has been titled "One-sided argumentation," the second one – "two-sided argumentation."

During the classical experiments of Charles Howland and his colleagues, it was found that two-sided argumentation is more suitable for educated audience, and also for those who do not agree with the opinion of the communicator. If the objectives of the audience match with those of the communicator and also listeners have incomplete secondary education or one or two courses of higher education, then one-sided argumentation will work better. We can make a conclusion, that in the case, when auditory is of low competence the best is prevailing

opinion thrust method. In the case of high competence level, it is better to give auditory the possibility to fulfill problem analysis and to synthesize the end result on the obtained data.

Konstantin Fedotov identifies the following types of consciousness[2]: philosophical, scientific, religious, artistic, household. Eliena Marantsman [2005] distinguishes people with the following mental composition, common with Fedotov's division: mathematical, humanitarian, artistic and practical.

Scientific type (changes over time at new knowledge receiving). Formed by basic public knowledge and special education. Phenomena understanding and ability to explain them, the cause and effect relationships forming. Manifested in intellectual activity as follows: an attempt to find new approaches or explanation, build/formulate some theory or hypothesis. Manifested in behavior, thoughtfulness, search for new information, teaching. Neural networks location that support this type of mind – left brain hemisphere: the relationship with consciousness; methodical thinking; thinking aimed at analysis and control; temporal processes; conceptual similarity.

People with a mathematical mind structure have symbolic thinking, when the information transformation using input rules takes place (such as algebraic rules). The result – an opinion, expressed in the structures form and formulas that capture the essential relationship between the characters.

Religious type (weakly disposed to changes, quickly formed). The basis of formation – religion and doctrine. The awareness of spiritual needs (creativity, knowledge of the world, religious states). Moral behavior and observance of morality. Ritual life mode, closeness to society. Manifested in intellectual activity as follows: focus on the only one (God, creativity, love). Manifested in behavior: focus on states and their ministry, detachment from the turmoil. Neural networks location that support this type of mind, – right brain hemisphere: auditory area; visual sphere; perception; complete function; creative function; image memory.

Philosophic type (weakly disposed to changes, slowly formed). The basis of learning – existing philosophic schools, studies. Integrated life view. Combines different knowledge and allows to look widely at phenomena. Manifested in intellectual activity as follows: how to connect one with the other? How one can influence the other? Manifested in behavior: thoughtfulness, observation. Neural networks location that support this type of mind, – right and left brain hemispheres.

The individuals with the humanitarian thinking structure prefer sign thinking mode. It is characterized by the information transformation with the help of conclusions. The signs are combined in the larger units. The result is an opinion

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[2]   www.ippnou.ru/article.php?idarticle=011169 [access: 15.12.2016].

in the concept or quotation form, which fixes the essential relations between the mentioned subjects.

Art type (changes over time due to changes in tastes and attitudes in the environment/society, emergence of new experience). The basis of formation – creative activities. Self-actualization of talents, intuitive attitude towards life, work. Manifested in intellectual activity as follows: new ideas appear, spontaneous binding one with another. Manifested in behavior, obsession with certain activities. Neural networks location that support this type of mind, – right brain hemisphere: auditory area; visual sphere; perception; complete function; creative function; image memory.

Subjects with artistic mind structure have image thinking. This is a separation from the object in space and time, the transformation of information through actions with images. Operations can be carried out sequentially and simultaneously as well. The result is the idea embodied in the new image.

Household type (changes quickly with changes in society and environmental conditions, taking into account the emergence of new technologies, development of new ways of doing things). Formed as a result of personal experience and learning derived from other people (parents, teachers, caregivers, friends, colleagues, etc.): how and what to do in a particular situation. It has its own specific features taking to the account the environment and culture (in different societies they build, treat, do business, cook, etc. in different way). Manifested in intellectual activity as follows: thoughts on the current situation and the problems that arise according to changes in the environment and main activity. Manifested in behavior: action direction to plan realization, obstacles removal, needs meeting. Neural networks location that support this type of mind, – left brain hemisphere: connection with consciousness; methodical thinking; thinking aimed at analysis and control; temporal processes; conceptual similarity.

People with practical mind structure have an objective thinking, which is characterized by the inextricable link with the object in space and time, the information transformation using substantive action, sequential operations. The result of this thinking is the idea embodied in the new design.

Given classification taking into consideration[3] can be summarized in Table 3.

The comparative characteristics of various teaching methods is given in work[4] (Table 4).

From the given tables can trace the relationship between students' consciousness types, relevant data transformations, typical for this type of awareness train-

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[3] www.elitarium.ru/sobesednik-tip-myshlenija-vosprijatie-informacii-reprezentativnaja-sistema -obshhenie-vlijanie/ [access: 12.01.2016].

[4] http://docplayer.ru/201500-Ispolzovanie-interaktivnyh-metodov-obucheniya-kak-sredstvo- aktivizacii-poznavatelnoy-deyatelnosti-uchashchihsya.html [access: 15.12.2016].

Table. 3. Concsiousness types and predominant information processing

| Consciousness types | Thinking structure | Result of mental processes | Dominating information processing |
|---|---|---|---|
| Household | Practical | Thinking construction | Kinesthetic |
| Art | Artistic | Image | Visual |
| Philosophic | Humanitarian | Concept, quotation | Audial, visual |
| Religious | | | |
| Scientific | Mathematic | Structure, formula | Audial, visual |

Source: own elaboration.

Table. 4. Comparative characteristics of various teaching methods

| Methods | Form | | Develop | | |
|---|---|---|---|---|---|
| | Knowledge | Skills | Thinking | Memory | Language |
| 1. Verbal | ++ | - | – | – | ++ |
| 2. Work with a book | + | + | + | + | + |
| 3. Teaching discourse | ++ | – | ++ | + | ++ |
| 4. Visual | + | + | + | ++ | – |
| 5. Independent work | ++ | ++ | ++ | + | + |
| 6. Practical | + | ++ | ++ | + | – |
| 7. Oral, written control | ++ | – | + | + | ++ |

++ solves very well; + solves partially; – solves weakly.
Source: own elaboration.
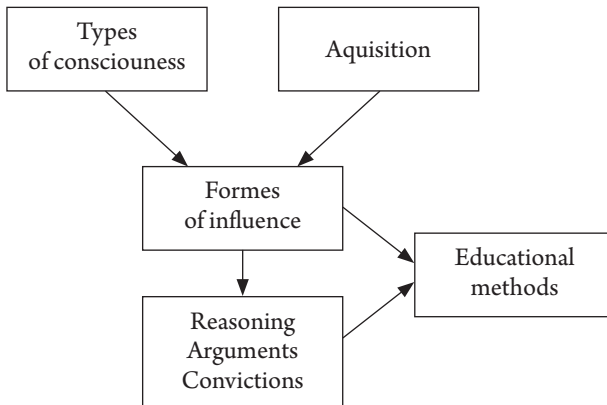


Figure 3. Consciousness types, level of acquisition of the student and pedagogical forms of influence

Source: own elaboration.

ing methods, which best suit students with different consciousness types and mind structure. It is necessary to take into account the elements of persuasion, proves, arguments and student's learning capability (Figure 3).

# 5. Conclusions

Diversity in approaches to methods classification does not determine the uncertainty in didactics on this point. This "natural process of learning methods evolution in which each author is entitled to own approach. Moreover, each classification is principally conceived by the author with the maximum coverage of the learning process factors in the system: learning objectives – the content and logical structure of educational material – the principles and means of teaching – teacher – student – methods. And still most of the classifications, although calculated on the ideal application universality, however, have their functional orientation and practically solve a specific pedagogical problem from the positions of the leading factor (the form, content, training material, etc.)" [Sydorenko 2006: 25].

The proposed new approach to teaching methods classification with the use of the memberwise disjunction mechanism in training methods classification allows to take to the account wider range of different teaching methods. The use of visualization using graphs makes the perception of the more complete classification and focuses on its features. Visualization with the help of graphs simplifies the perception of such classification and focuses attention on its features.

Depending on the objectives of effective learning provision, it is possible to change the dominant criteria, and accordingly choose an effective, in this case, teaching methods. In the given example, a logical connection between teaching methods and students' types of consciousness and thinking is shown.

# References

Aleksjuk A., 1981, *Zagalni metody navchannja v shkoli*, Kyjiv: Znannja.

Babanskij Yu., 1985, *Metody obuchenia v sovremennoj obrazovatelnoj shkole*, Moskva: Prosveschenie.

Fedotov K., *Tipy soznania i upravlencheskije reshenia*, www.ippnou.ru/article.php?idarticle=011169 [access: 15.12.2016].

*Kak vyjasnjat i ispolzovat dominirujushchije tipy myshlenia vashyh sobesednikov*, www.elitarium.ru/sobesednik-tip-myshlenija-vosprijatie-informacii-reprezentativnaja-sistema-obshhenie-vlijanie/ [access: 15.12.2016].

Kunicina V.N., Kazarinova N.V., Pogolsha V.M., 2001, *Mezlichnostnoje obshchenije*, SPb: Piter.

Marantsman M.I., 1986, *Formy i metody obshcheobrazovatelnoj podgotovki i kommunisti-cheskogo vospitania uchshchihsja srednich PTU*, Moskva: Pedagogika.

*Metody obuchenia*, http://vaniorolap.narod.ru/theme11.html [access: 15.12.2016].

Onyshchuk V.A., Kobzar B. et al., 1987, *Didaktika sovremennoj shkoly*, Kyjiv: Rad.shkola.

Podlasyj I.P., 2003, *Pedagogika*, Kniga 1: *Obshije polorzenia. Proces obuchenia*, Moskva: Vlados.

Rzeleznjakova O.M., 2006, Dopolnitelnost kak inovtsionnyj podhod k klasdifikacii i vyboru metodov obuchenia, *Innovacii v obrazovaniji*, 4, 46-54.

Slsatenin V.A., Isajev I.F., Shyjanov E.N., 2002, *Pedagogika*, Moskva: Izdatelskij tsentr "Akademia."

Sydorenko V.K., 2006, Klasyfikacia metodiv nvchannia na osnovi vidnoshen kategoriji zmistu i formy, *Suchasni informacijni metodyky navchannia u pidgotovci fahivciv: metodologia, teoria, dosvid, problemy*, 9, 21-27.

Vinogradova E., Golovenko T., Voronovych V., Kudrjavtseva S., Telesh N., *Ispolzovanije interaktivnyh metodov obuchenia kak sredstvo obuchenia poznavatelnoj dejatelnosti uchshihsja*, http://docplayer.ru/201500-Ispolzovanie-interaktivnyh-metodov-obucheniya-kak-sredstvo-aktivizacii-poznavatelnoy-deyatelnosti-uchashchihsya.html, [access: 15.12.2016].

Zinko R.V., 2015, *Vykorystannja metodu pochlennoji dyzjunkciji dlja syntezu mashyn*, XIV Miznarodna naukovo-technichna konferencia "Vibraciji v technici i technologijah," Ukraina, Dnipropetrovsk.

## Zastosowanie mechanizmu dysjunkcji w wyborze metody nauczania a osobowość studenta

**Streszczenie.** Rola klasyfikacji metod nauczania polega na tym, że umożliwia analizę potencjału poszczególnych metod i określa sposoby ich doskonalenia, rozwoju i realizacji. Istnienie wielu typologii metod nauczania odzwierciedla złożoność zagadnienia i wagę zadań stawianych przez społeczeństwo przed współczesną szkołą. Celem artykułu jest przedstawienie podejścia klasyfikacyjnego opartego na mechanizmie dysjunkcji, które uwzględnia większą liczbę czynników. Dzięki zastosowaniu diagramów ilustrujących proponowaną klasyfikację możliwe jest zachowanie zawartości informacyjnej wielowymiarowych danych w przejrzystej formie, co ułatwia zrozumienie klasyfikacji oraz uwypukla jej istotne cechy. W zależności od konkretnych warunków efektywnego kształcenia podejście to pozwala na zmianę kryteriów i wybór odpowiedniej metody. Artykuł przedstawia związek między metodami nauczania a typami osobowości uczniów i ich preferencjami poznawczymi.

**Słowa kluczowe:** klasyfikacja metod nauczania, mechanizm dysjunkcji, diagram, wizualizacja, preferencje poznawcze, typy osobowości

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# Education for Sustainable Development: A Case Study of Incorporating Key Elements through Course Design

**Abstract.** Sustainable development is a challenge worldwide. The nine states located in the Baltic Sea Region, with different political systems, have developed different ways of coping with environmental issues and incorporating them in the national education systems. Early joint efforts to minimize these differences undertaken by the Helsinki Commission (HELCOM) and the Baltic University Programme (BUP) to bridge these differences are impressive. Still, we need to continue learning about environmental history, policy formulation and current state of affairs in order to get ready for future challenges. With respect to contemporary discussions on improving educational processes, the aim of this paper is to present a good practice example of teaching at a BUP member university, in the light of ESD principles. A specific course, Environmental Politics, focusing on capacity-building for national environmental policies, is scrutinized in order to find out how to engage students on this topic. The findings suggest that structured discussions of environmental cases in small seminar groups are conducive to teaching ESD at a BUP member university.

**Keywords:** Baltic Sea Region, capacity-building, environmental policies and governance, education for sustainable development

## 1. Introduction

A general guideline in education for sustainable development (ESD) is stressing the value of skills and abilities to apply theoretical knowledge to practical problems. As students are prepared for a fast changing world, knowledge is simply

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not enough. Further, in order to be efficient and successful in a professional career, as well as making a difference for the environment and the change towards a more sustainable society, students should stay alert and keep up-to-date with news, innovations and research in their field of study, even after graduating. This is to imply a life-long learning process [Klavins & Zaloksnis 2009]. The ultimate goal of education is behavioral change and as such, the overarching goal of environmental education is to impart knowledge that operationalizes responsible environmental conduct in students from the classroom to wider society.

Teachers are facing these new challenges as well. They should be open for new roles, like coaches and team leaders, at the same time having to revise their knowledge of their subject into a more holistic and systemic setting. Besides, student groups are not as homogeneous as before [Lindroos 2015: 37]. Internationalization in universities also opens up the competition for attracting students and researchers. Hence, new ways of support in study counseling, learning provisions and learning methods are formulated in higher education, with deeper innovation in staff development [UNESCO 2014].

Studying a complicated context of various societal systems and processes, several ESD learning goals are relevant to recall, e.g., the dialectic between tradition and innovation. As can be seen in the Baltic Sea Region (BSR), traditional state-centered governmental processes, including an early international co-operation, have been complemented with governance processes with a joint role of governmental, semi-governmental, non-governmental, and private institutions. Policy-making authority is shared with business, environmental and other non-governmental organizations (NGOs). There is a vast array of activities in shaping and sustaining networks within different territorial bonds, such as a region, state, county, municipality and city. The belief is that a dynamic, polycentric order takes advantage of local specialization and scale and enhances innovation, adaption and learning for sustainable development [Joas, Jahn & Kern 2008]. It is for certain a challenge to study and discuss such a demanding issue as capacity-building for sustainability. The students attending the course serving as the case study, "Environmental Politics," come from different countries, from different learning environments with different main subject. They have one thing in common though, a genuine interest in environmental issues and in discussing sustainable development. The aim of the teachers is to provide them with tools to do so in a comparative manner. This article will in the next sections discuss how capacity for environmental policy is built through the course "Environmental Politics." It will focus on the logic of comparative studies, exemplified with a framework for analyzing environmental capacity-building, and demonstrates how this is assimilated into students' discussions.

## 2. Education for sustainable development

Education for sustainable development, ESD, identifies skills like creative and critical thinking, communication, diversity, ethics and social responsibility, internationalization, engagement and sustainability [Klavins & Zaloksnis 2009: 283]. Good learning strategies are valuable to inculcating these skills in students, especially considering that course materials and literature gets outdated in a few years, depending on subject. Students need energy and compassion for the mission to create a sustainable future, and there are good examples documented on how these things fall into place. During their studies, students mature and build their capacity to take on a leadership role in a region meeting complex and difficult challenges of our times [Grandin et al. 2010: 283].

However, gaining of knowledge is not enough, ESD learning also include, according to Daniella Tilbury [2011: 8]:
  – learning to ask critical questions,
  – learning to clarify one's own values,
  – learning to envision more positive and sustainable futures,
  – learning to think systematically,
  – learning to respond through applied learning,
  – learning to explore the dialectic between tradition and innovation.

This framework is comprehensive, as it is developed from research on numerous cases and is incorporated as recommendations in a UNESCO report. It is a culmination of experts' review of processes and learning in ESD and as such, this article applies these principles in analysis. It uses the framework to show that the course 'Environmental Politics' is a good practice example of teaching at a Baltic University Program (BUP) University as it incorporates all the above elements in the course design. Several case studies and best practice presentations have already been conducted within the BUP sphere. In fact, *Studia Periegetica* already devoted an entire issue [1(15)/2016] to ESD,[1] which has been of great value evaluating and developing this very course.

## 3. The case study: environmental politics

The course "Environmental Politics" is taught to graduate students at Abo Akademi University at the master's level. The aim of the course is to expose students to material that present capacity building in environmental politics. The course

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[1] www.wydawnictwo.wsb.pl/sites/www.wydawnictwo.wsb.pl/files/czasopisma-tresc/Studia% 20P_15_net.pdf [access: 16.12.2016].

ultimately aims to build students capacity for environmental problem solving through critical thinking of key material, such as course literature by Jänicke and Weidner. The course is taken by local students as well as exchange students at Åbo Akademi University, and is offered once per year during the autumn term. The pass rate in the course is consistent with other courses. Assessment of the course is usually through the means of in class participation, assignments, project presentation and a final examination. The following sections show how the principles of ESD learning as articulated by Tilbury [2011] are incorporated into the course design.

## 3.1. Learning to ask critical questions

Certain key processes have been defined for making ESD practices successful, among others processes of collaboration and dialog, and processes of active and participatory learning [Tilbury 2011]. The teaching mode in this specific course is lectures and seminars. In seminars, individual presentations by students are at the core in providing understanding of a certain country and its environmental policy system. However, the discussion following a presentation is the most important part of the whole course. In this way, all students play an active part, and this was carefully planned to facilitate critical thinking through of complex environmental issues such as the role of state and society. Or in other words: "Learning for sustainable development also means that we need to change from being passive recipients into active co-producers of knowledge by taking a more active role in our education" [Grandin et al. 2010: 284].

The stakes are high. In real life, in debates and traditional decision making processes, citizens and politicians are in many ways dependent on expert knowledge which is difficult to grasp and almost impossible to question. This is a general feature of developed societies where a high degree of specialization makes communication between experts, scientists and professionals of different fields problematic. In a globalized world communication between different groups of actors and stakeholders is vital to any solution in the complex problems of e.g. energy and environment. In other words, discussions and communication skills are vital to our students.

So far exchange students have been an important target group for this course. There are ongoing discussions and plans to develop an online version of the course for future students. However, contact online does not beat the social connections and bonds that are made when students meet and interact in the classroom setting. It is difficult to imagine that the same commitment would be achieved online as in a close-knit, highly motivated team of students, working together an academic year. But that remains to be tested.

## 3.2. Learning to clarify one's own values

In the course presented here, this has been a guiding principle for lectures and seminars where special emphasis is placed on developing confidence in students own working skills, capacity to perform and present their knowledge to fellow students, researchers and members of the public. When students work together in seminar groups for a longer time period, they get the opportunity to test their own assumptions by listening to the views of others. This helps them in clarifying their own values. As a bonus, students can also make contacts for the future, and build up potential networks. These peers from class can be experts in the future who have the potential to provide helpful information.

## 3.3. Learning to envision more positive and sustainable futures

One way in which this course guides students in learning to envision alternative futures is through institutionalization. Institutionalization refers to the period and the process through which the structures and rules for a specific policy area, in this case environmental policy sector, are established. Criteria of institutionalization were developed and presented by Martin Jänicke (see for example his article 1992) and applied in his later studies [1997; 2002]. These criteria, or steps of institutionalization are listed here below. Several other studies have found this set of criteria useful in comparative research [e.g., Governing the Environment 1996; Hermanson 2006].

Criteria or steps of institutionalization:
– establishment of environmental ministry,
– establishment of national environmental agency,
– framework of environmental legislation,
– environmental concern in constitution,
– publication of first environmental report,
– independent central council for environmental advice.

Students are able to envision more stable and sustainable futures when they work through the steps above, as it forces them to examine the rules that lead to the establishment of specific environmental policies.

It is also through examination of society's capacity for environmental protection and sustainable development that students learn to envision more sustainable futures. Society's capacity for environmental protection and sustainable development refers to society's ability to identify and solve environmental problems. This includes a combined application of several factors, e.g. set of ac-

tors, strategies and structural framework conditions, and case specific contexts [Jänicke & Weidner 1997: 1-24; Weidner & Jänicke 2002: 1-18]. By examining the literature on solving environmental problems, students are able to think through material on this topic and can identify both good and bad examples of environmental protection efforts.

## 3.4. Learning to think systematically

Comparative studies are used as a tool to enable students to think systematically. With an interest in operating policies, administrative structures and organizational theory, political science is, at least to some extent, involved in comparative research strategies. Students are curious to know what political systems have in common, and in what ways they differ, and perhaps what conditions make for stability or change. The comparative method as such is usually conducted in a stricter sense with few cases and potentially many sets of variables. In a more general way, following a joint outline in country studies, the prerequisites for comparison is granted. This strategy is commonly used in country studies [e.g. Governing the Environment 1996]. The aim of the comparative method is often of understanding and explaining character. We gain a lot of information about a certain political system if we compare it to other political systems, recognizing similarities and differences, and examine the origins of a specific similarity or difference [Joas & Hermanson 1999: 5]. Even macro-comparative politics can take country specific environmental performance indices into account [Jahn 2016].

First of all, we need a clear structure in order to grasp and orientate among different aspects of a complicated and convoluted policy formula of the BSR mentioned in the introduction. In this specific course, a theoretical framework developed by Martin Jänicke is applied to set the concepts needed for a comparison. It enables students to focus on specific topics, step by step, and enabling them to gain a comprehensive understanding through comparative work that they conduct individually (but in close contact with their seminar group). This focused step by step assimilation of the material by students is what enables systematic learning that is necessary for ESD.

## 3.5. Learning to respond through applied learning

Students are able to apply their knowledge gained in the course through various research activities. For example, the selection of countries and policy areas is made according to students' own choice and preferences, through information gathered on cases through applied research. Then national environmental poli-

cies are dealt with in presentations and seminar discussions. It goes without saying that the teachers should find out whether everyone is confident with the task and feeling comfortable in the seminar group. Diffuse instructions will be time consuming, therefore, the course 'Environmental Politics' start out with introduction lectures on both comparative methods and the theoretical framework.

## 3.6. Learning to explore the dialectic between tradition and innovation

As part of the course, country studies are conducted, pointing towards a change in processes. However, with a traditional focus on the institutionalization phase, the scope might be too narrow to reveal that. New concepts are then better off in taking new administrative patterns into account. However, ".. although the environmental issue does present society with new challenges, the institutional capacities of the political and administrative system, in combination with prevailing national policy style, may be enough developed to be able to meet the environment challenge, and in so doing basically absorb or coopt this new political concern into 'traditional' politics" [Governing the Environment 1996: 14].

Through the use of the concept of "governance," teachers now want to clarify that politics and the policy-making processes have changed indeed. The main idea is that before, roughly until the 1970s, nation states, through their elected representatives, determined national policies more or less on their own. The leading concept was "government." Nowadays, because of the economic globalization, but also because of the emergence and enlargement of the European Union and the regions strengthening their powers, nation states no longer exercise exclusive power. The set of actors has changed, and we talk about governance instead of traditional government [Joas, Jahn & Kern 2008].

But political governance is also about highlighting that the policy-making process takes place in a different way today. It acknowledges the development of networks, informal coalitions and stakeholder activities. In particular the EU policy-making is shaped by different networks, where representatives of international, national and regional levels, non-profit organizations and companies are involved in the process.

The Baltic Sea Region provides a perfect case for exploring these changes. The Baltic Sea, a rather shallow sea of brackish water, is highly vulnerable to pollution. About 90 million people live in the region, administrated by nine different countries. Furthermore, the governance discussion is right at its edge in this context, because several new forums for sustainable decision-making were introduced, while existing administrative and political structures have shown considerable strength and endurance [Joas, Jahn & Kern 2008: 4].

Since the end of the Cold War the Baltic Sea Region has developed into one of the most dynamic areas in Europe. While only two countries surrounding the Baltic Sea, Denmark and West Germany, were members of the EC/EU before 1990, this situation changed dramatically after the 1995 enlargement (Finland and Sweden) and even more after the 2004 enlargement, when Poland and the three Baltic republics (Estonia, Latvia and Lithuania) became full EU members. Today the Baltic Sea has almost become an internal Sea of the EU, with Russia as the only exception. The European Union Strategy for the Baltic Sea Region (EUSBSR)[2] from 2009, is the first macro-regional strategy in Europe.

As already mentioned, nine different political systems surrounding the Baltic Sea had developed ways to cope with environmental problems in their national contexts. Early joint efforts to protect the environment were also taken in the 1970s, as manifested in, for example, the Baltic Marine Environment Protection Commission – the Helsinki Commission (HELCOM)[3] and the Convention on the Protection of the Marine Environment of the Baltic Sea Area – the Helsinki Convention in 1992.[4] Nevertheless, there were differences in how and when environmental issues had reached the political agenda, and how the traditional, governmental systems responded and acted on these challenges. A new style of working together, in governance processes with a joint role of governmental, semi-governmental, non-governmental, and private institutions, occurred as a parallel development. Of particular note are the Agenda 21 processes with Baltic Agenda 21, and transnational networks, such as Union of the Baltic Cities[5] and Cities for Climate Protection,[6] the latter established in 1990 by the International Union of Local Authorities and the United Nations Environment Programme as part of a large global transnational network, the International Council for Local Environment Initiatives.

The countries in the BSR are very diverse in areas such as democracy, welfare, environmental policy, and human rights. Although intergovernmental cooperation between these unequal neighbors already started in the Cold War period, the end of the Cold War triggered new forms of cooperation and governance. Two trends which appeared are considered characteristic for the development in the BSR: transnationalization and Europeanization [Kern & Löffelsend 2008]. Transnationalization includes the mobilization of both civil society actors and subregional governments. Moreover, the EU has become a major player in the region and governance in the BSR has become embedded in European govern-

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[2] www.balticsea-region-strategy.eu [access: 16.12.2016].
[3] www.helcom.fi/about-us [access: 16.12.2016].
[4] www.helcom.fi/documents/about%20us/convention%20and%20commitments/helsinki%20 convention/ 1992_convention_1108.pdf [access: 16.12.2016].
[5] www.ubc.net [access: 16.12.2016].
[6] www.iclei.org [access: 16.12.2016].

ance [Joas, Jahn & Kern 2008: 8; Kern & Löffelsend 2008: 137]. These emerging themes allow students to explore the interaction between tradition and innovation.

## 4. Discussion

In this article, a course Environmental Politics was presented and discussed as being a good practice case on ESD. The skills students need today are somewhat different from the knowledge-based examination. Perhaps university courses could be even more focused on creative and critical thinking, communication and interaction with society, outspoken on ethics and social responsibility, engaged in internationalization and sustainability issues. Several arguments were formulated on why we should continue discussing participation and democracy in order to reach a sustainable society. The main argument for extending democracy and stressing broad participation in environmental activities, especially decision-making, is the perceived role of the citizens for achieving a sustainable development. The Brundtland Report counts clearly on the citizens: "The law alone cannot enforce the common interest. It principally needs community knowledge and support, which entails greater public participation in the decisions that affect the environment" [WCED 1987: 63].

There are also arguments that environmental issues are so complex, that an array of different participants and actors is needed to grasp it all. In other words, the quality in decision-making is also related to broad and multiple participation [WCED 1987]. Today, interdisciplinary education is appreciated among students and universities are incorporating professionals with different backgrounds as guest lecturers.

In education these qualities could also be encouraged in courses and seminars through collaboration and networking. BUP offers conferences, workshops and field trips, all kind of activities aimed at improving skills in collaboration and team-working. It is a tremendous work being done under this umbrella. As a teacher, this support is important for developing the education for sustainable development.

The methods and framework used in the course presented in this article, provide just an example on how to structure a complicated context and involve students as "country experts" when studying national environmental policies. Solid knowledge and proper understanding of background facts are preconditions for any attempt to comprehend the current context, and to interpret the structures of society and the processes going on. When students have done their homework, they will be able to evaluate traditional paths of development, present the cur-

rent state of affairs and even come up with more visionary alternatives that really promote sustainable societies.

## 5. Conclusion

This article presented the course "Environmental Politics" as an example of good practice in environmental capacity building for a BUP University for education for sustainable development. It uses the Tilbury [2011] framework to show that this is a comprehensive course that covers all the key areas necessary for environmental capacity building in students. It shows that students learn to ask critical questions through discussions and clarify their values through presentations and critical questioning. Through the course, students learn to envision more positive and sustainable futures through grappling with institutionalization theory and they learn to think systematically through case study applications of the materials presented in class. This also leads to applied learning, as students can explore material for the cases and select cases through applied research. Finally, it is through exploring the material on environmental change and innovation in regions such as the Baltic Sea, that students are challenged to explore the dialectic between tradition and innovation.

## References

EUSBSR, 2009, *The European Union Strategy for the Baltic Sea Region*, www.balticsea-region-strategy.eu [access: 16.12.2016].

Governing the Environment. Politics, Policy and Organization in the Nordic Countries (Nord, 5), 1996, Copenhagen: Nordic Council of Ministers.

Grandin J., Apine L., Kovbasko O., Zhuk Y., 2010, A Students' Perspective on Sustainable Development: It Is Our Task to Create an Attractive, Sustainable Future!, in M. Klavins, W.L. Filho, J. Zaloksnis (eds), 2010, *Environment and Sustainable Development*, Riga: University of Latvia Press.

Hermanson A.-S., 2006, *Miljövårdens institutionalisering i Finland (The institutionalization of environmental protection in Finland)*. Åbo.

Jahn D., 2016, *The Politics of Environmental Performance. Institutions and Preferences in Industrialized Democracies*. Cambridge: Cambridge University Press.

Jänicke M., 1992, Conditions for Environmental Policy Success: An International Comparison, *The Environmentalist*, 12(1), 47-58.

Jänicke M., Weidner H. (eds), 1997, *National Environmental Policies: A Comparative Study of Capacity-Building*. Berlin: Springer.

Joas M., Hermanson A.-S., (eds), 1999, *The Nordic Environments. Comparing Political, Administrative, and Policy Aspects*. Aldershot: Ashgate.

Joas M., Jahn D., Kern K., 2008, Governance in the Baltic Sea Region: Balancing States, Cities and People, in M. Joas, D. Jahn, K. Kern (eds), *Governing a Common Sea. Environmental Policies in the Baltic Sea Region.* London: Earthscan.

Kern K., Löffelsend T., 2008, Governance beyond the Nation State: Transnationalization and Europeanization of the Baltic Sea Region, in M. Joas, D. Jahn, K. Kern (eds), *Governing a Common Sea. Environmental Policies in the Baltic Sea Region.* London: Earthscan.

Klavins M., Zaloksnis J. (eds), 2009, *Environmental Education at Universities,* Riga: University of Latvia Press.

Lindroos, P., 2015, Introducing education for sustainable development – challenges for students and teachers, in W.L. Filho, A.Úbelis, D. Berzina (eds), *Sustainable Development, Knowledge Society and Smart Future Manufacturing Technologies,* World Sustainability Series. Berlin: Springer.

*Studia Periegetica*, 2016, 1(15), Sustainable Development in the Baltic Sea Region – Focus on Education, www.wydawnictwo.wsb.pl/sites/www.wydawnictwo.wsb.pl/files/czasopisma-tresc/Studia% 20P_15_net.pdf [access: 16.12.2016].

Suomalainen S., 2016, A European Project for the Education for Sustainable Development in Higher Education. *Studia Periegetica*, 1(15), 159-167.

Tilbury D., 2011, *Education for Sustainable Development: An Expert Review of Processes and Learning*, Paris: UNESCO, http://unesdoc.unesco.org/images/0019/001914/191442e.pdf [access: 16.12.2016].

UNESCO, 2014, *Shaping the Future We Want – UN Decade of Education for Sustainable Development (2005-2014). Final Report*, http://unesdoc.unesco.org/images/0023/002301/230171e.pdf [access: 16.12.2016].

WCED (World Commission on the Environment and Development), 1987, *Our Common Future.* Oxford: Oxford University Press (also known as The Brundtland Report).

Weidner H., Jänicke M. (eds), 2002, *Capacity Building in National Environmental Policy: A Comparative Study of 17 Countries*, Berlin: Springer.

www.helcom.fi/about-us [access: 16.12.2016].

www.helcom.fi/documents/about%20us/convention%20and%20commitments/helsinki%20convention/ 1992_convention_1108.pdf [access: 16.12.2016].

www.iclei.org [access: 16.12.2016].

www.ubc.net [access: 16.12.2016].

## Edukacja dla zrównoważonego rozwoju: przykład uwzględnienia kluczowych elementów treści na etapie projektowania programu nauczania

**Streszczenie.** Zrównoważony rozwój stanowi wyzwanie na całym świecie. Dziewięć krajów o różnych systemach politycznych, położonych w regionie Morza Bałtyckiego, wypracowało różne sposoby radzenia sobie z zagadnieniami środowiskowymi i stworzyło odmienne systemy edukacji w tym zakresie w ramach krajowego systemu kształcenia. Pierwsze wspólne działania w celu

zmniejszenia tych różnic, podejmowane m.in. przez Komisję Helsińską oraz w ramach Programu Uniwersytetu Bałtyckiego (PUB), są imponujące. Mimo to nadal należy poznawać historię środowiska, doskonalić sposoby tworzenia polityki środowiskowej oraz poszerzać wiedzę o obecnym stanie rzeczy, aby przygotować się na wyzwania przyszłości. W związku z dyskusjami na temat poprawy procesów kształcenia celem artykułu jest przedstawienie przykładu dobrych praktyk kształcenia na jednej z uczelni stowarzyszonych w ramach BUP, w świetle zasad EZR. Na przykładzie jednego przedmiotu, polityki środowiskowej, który skupia się na budowaniu potencjału dla potrzeb krajowej polityki środowiskowej, analizie poddano sposoby zainteresowania studentów tematyką przedmiotu. Wyniki wskazują, że analiza konkretnych przypadków problemów środowiskowych w zorganizowanej dyskusji prowadzonej w małych grupach seminaryjnych sprzyja realizacji EZR.

**Słowa kluczowe:** region Morza Bałtyckiego, budowanie potencjału, polityka środowiskowa i sprawowanie rządów, edukacja dla zrównoważonego rozwoju

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# ESD as a Positive Side Effect of International Activities: The Case-Study of the CROSSROADS 2.0 Project

**Abstract.** Education for Sustainable Development (ESD) has been approached in different ways by University faculties, secondary school teachers, and researches. However, the contribution to the ESD system made by international university projects has not been sufficiently discussed in the literature so far. The paper presents a case study and theoretical analysis of the role played by international university cooperation projects aimed at putting into practice the integration of in-class and extra-curriculum activities in ESD. This approach to education for sustainable development has been adopted in the Kaliningrad region (Russian Federation), one of the cross-border Baltic regions. The case study covers all the three dimensions of sustainability, i.e. ecological, economic and social development, as well as the improvement of regional environment. Legislative documents and projects developed by federal and regional government are mentioned, as well as obstacles to and prospects for the development of the integrated ESD approach. The project called "Lagoons as crossroads for tourism and interactions of peoples of South-East Baltic: from the history to present" is conducted by three countries and continues the work started in the CROSSROADS project. Its outcomes are used to support the conclusions drawn from existing theoretical approaches.

**Keywords:** sustainability, ESD, cross-border cooperation, case-study, integrated approach

## 1. Introduction

Education for Sustainable Development has become one of the buzz-words of today, especially in conjunction with the recently ended UNESCO ESD Decade.

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Many organizations have been and are getting involved in developing ESD curricula, organizing events, analysing the criteria, the outcomes, the stakeholders. Consent on the aims, goals, methods is still being worked on both by practitioners and researchers [Kopnina 2012b; Kopnina & Meijers 2014; Schroter 2010; UNEP and UNESCO 1976; UNESCO 2005; Wals 2007; 2009].

According to the "Education for Sustainable Development in Action Learning & Training Tools no. 2 – 2010" and "Education for Sustainable Development is relevant to everyone, at whatever stage of life they are and in any context. ESD is an integral part of lifelong learning, engaging all possible learning spaces-formal, non-formal and informal, from early childhood to adult life. The *ESD Lens* is based upon a whole-system approach to education, positioning ESD within national education systems, policies and programmes. A whole-system approach to ESD involves close integration of the aims of education with the broad span of social, economic, environmental and cultural policies for sustainable development. There is a range of different factors that shape how ESD is viewed and how it can be developed and practised in any context" [Education for Sustainable Development Lens 2010: 17].

The authors agree to the above cited document in understanding "the all-encompassing scope of ESD, and its aim to equip individuals and societies with skills and capacities to transform attitudes and lifestyles, suggests that a fifth pillar of learning can be added: "Learning to transform oneself and society – knowledge, values and skills for a sustainable future". (These outcomes of education were listed in World Declaration on Education for All 1990, Art. 1, para. 1].

Of special interest to the present paper is the clear and unequivocal approach to ESD as a life-long process, that "engages formal, non-formal and informal education; addresses content while taking context into account; includes global issues and local priorities; and is cross-disciplinary" [World Declaration on Education for All 1990: 52].

Having underscored their strong belief in the non-stop and all-embracive character of the ESD process the authors fully realize the limitations that the project format has for ESD. A comparatively short term duration, lack of long-term responsibility for the achieved results, no control over the further development of the participants on the way to sustainable life-style and values, little influence upon the legislative, economic, political systems of the neighbouring participant states make just a very incomplete list of such limitations. However, activities directed at creating and developing sustainable tourism destinations and events described below necessarily presuppose ESD with a far-reaching effect.

## 2. Background

I. Kant Baltic Federal University of Russia (Russian Federation, Kaliningrad) has been actively promoting and initiating international cross-border Projects aimed at promoting sustainable development in the region.

One of the recent Projects was named "CROSSROADS 2.0 – Lagoons as crossroads for tourism and interactions of peoples of South-East Baltic: from the history to present." It was financed by the Cross-border cooperation Programme of European Neighbourhood and Partnership Instrument Lithuania-Poland-Russia 2007-2013. The overall aim of the Project was the improvement of attractiveness and competitiveness of Lithuania-Poland-Kaliningrad region cross-border area adjacent to the Curonian and Vistula lagoons in order to raise tourist inflow. The Project lasted from November 2012 till June 2015, and its total Project budget was 1 840 847,810 EUR.

The Project has won the first place among 60 similar Projects financed by the Cross-border cooperation Programme of European Neighbourhood and Partnership Instrument Lithuania–Poland–Russia 2007-2013.

Technically the Project was aimed at meeting the demands of the target programme "Development of the Kaliningrad region up to 2020", which indicates, that "implementation of environmental measures and international Projects aimed at ecotourism development, designing new eco-routes and destinations, and development of rural and active tourism, will have direct positive environmental impact on some districts as well as the region as a whole"[1].

The Project was directed at putting into practice sustainable tourism in the Kaliningrad region as one of the Eco-regions in the Baltic Sea Region; it addressed all the three aspects of sustainability, i.e. regional economic and social development, improvement of regional environment [Belova 2010: 48-50].

As the tourism industry has a multiplier effect in the economy, the Project contributed to the sustainable development of other sectors of the economy in the region and to the efficiency of enterprises in other sectors of the regional economic complex; simultaneous development of sectors of economic activity and the transition to sustainable development promote a balanced development; creation of favourable investment climate in the region and the creation of Special Economic Zone of tourist-recreational type "Curonian Spit" (one of seven in Russia).[2]

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[1]  Project CROSSROADS 2.0.: www.kantiana.ru/crossroads2/ [access: 18.11.2016].
[2]  Russian part of the National Park "Curonian Spit": www.park-kosa.ru [access: 18.11.2016].

To achieve the aim of the Project the following objectives were singled out:

1. Preparation and implementation of small-scale investments into development and renovation of existing and creation of new objects of innovative tourism infrastructure, based on the rich and unique common cultural and historical heritage of the cross-border area and allow to use this heritage for the joint creation of the cross-border tourist products contributing to the regional growth. This aim answers the sustainability value of preserving the heritage. Through implementing this objective, the Project contributed to the formation of awareness and knowledge, needed to both shaping the mental models and to introducing sustainability practices.

2. Strengthening collaboration between people, NGOs and local authorities and support of joint actions in the sphere of development, promotion and quality improvement of the tourist products in the cross-border area of Vistula and Curonian lagoons. Collaboration underscores the universal responsibility aspect of both sustainability and ESD. Moreover, while answering the local needs, reflecting the conditions and perceptions of the people of Russia, Lithuania and Poland it has a multiplying effect, due to the fact that the professionals, the local population and the visitors get involved into sustainable practices.

3. Implementation of joint actions aimed at protection and sustainable use of cultural and historical heritage of cross-border area of Lithuania, Poland and Kaliningrad region of Russian Federation adjacent to the Curonian and Vistula lagoons.

This objective is clearly directed at shaping the skills needed for sustainable practices. The outcome of the Project includes two renewed (reconstructed) tourism infrastructure objects of 1 open-air museum of the Viking epoch "Ancient Sambia"; 14 tourism products, jointly created by the partners; 1 jointly labelled tourism destination. 39 239 target persons participated in various events.

## 3. Discussion

The authors argue that among other factors, the total number of the people involved in the various Project activities as well as the vast variety of the events involving several sectors of population starting from financially deprived children to local authorities in three neighbouring countries can be regarded as a clear indicator of the ESD outreach, as one can hardly be involved in developing sustainable tourism without tackling with the objectives of education for sustainability, summarized as promoting:

– "Human sustainability. Maintaining human capital such as health, education, knowledge,

– Social sustainability (organizations and networks). Maintaining social capital,

– Economic (financial) sustainability. Keeping capital intact,

– Natural (environmental) sustainability. Protecting natural capitals (e.g. water, land, air, minerals, etc.)" [Schroter 2010].

An important aspect of ESD that has found little reflection in the literature so far is that Education should not necessarily be constricted to specifically designed educational events or programmes. The setting of all types of activities will unavoidably lead to changes in world views, actions, behaviours, values, be it consciously or not. While constructing the "Sambia" museum, doing the diggings, developing eco-routes everybody involved had no other option than to think and act along the lines of sustainability. Hence, by stating its overall aim the Project set the framework for educating people, for acquiring and strengthening the sustainable development approach to life.

The strength of the Project was in a combination of formal, non-formal and free-time educational activities. It overcame the sometimes evident gap between "What we say" and "What we do," engaging the participants in lectures, discussions, Project development, Project application, various hands-on activities.

The Project has also performed a direct educational impact on the representatives of Lithuania, Poland and Russian Federation.

While promoting sustainable tourism "CROSSROADS 2.0" has realized a number of important educational activities that, in full accord with the ESD principles, were "based on the principles of inter- and intra-generational equity, social justice, fair distribution of resources and community participation (amongst others), which underlie sustainable development" [Schroter 2010: 52].

It became feasible thanks to the fact that the Project was implemented together by 13 partners from cross-border areas adjacent to the Curonian and Vistula lagoons of Russia, Lithuania and Poland. Six partners out of 13 were involved in the educational events. It is worth mentioning that these partners included educational and non-educational organizations, governmental bodies and NGOs. They were

– I. Kant Baltic Federal University (Russia) (Lead Partner of the Project),

– Klaipeda University (Lithuania),

– Polish Maritime Museum in Gdansk (Poland),

– Folk Architecture museum – Ethnographic Park in Olsztynek (Poland),

– National Park Curonian Spit (Russia),

– NGO Traditional Group "Speaking Water."

The list suggests that one of the salient features of ESD is reflected here, i.e. that of inter-sectorality. The participation of representatives of three different cultures was another strength of the Project. Five activities within the Project

CROSSROADS 2.0 of the CBC Programme "Lithuania–Poland–Russia" 2007-2013 were directly dedicated to the education.[3]

International Course on sustainable use of the natural, cultural and historical heritage within the cross-border area for students from Russia (Kaliningrad), Poland and Lithuania adjacent to the Curonian and Vistula lagoons was designed and carried out to provide the students with necessary knowledge. The course was divided into 3-4-days that took place in all the three participant countries.[4]

The first part was organized in Kaliningrad, at the I. Kant Baltic Federal University of Russia. Altogether 30 students attended the course, i.e.10 undergraduate students majoring in geography, history and tourism, from I. Kant Baltic Federal University (RU), Klaipeda University (LT), Vilnius University (LT), Gdansk University (PL), Gdansk University of Technology (PL). During the course they were offered 15 lectures in 5 topics, presented by associate professors and professors of the I. Kant Baltic Federal Universities in the field of geography, history, geo-ecology, archaeology, economics, urban planning, tourism:

– Cultural and historical heritage of the cross-border area adjacent to Curonian and Vistula lagoons;

– Social-demographic and economic aspects of development of the South-Eastern Baltic in historical perspective;

– GIS technologies application for preservation and sustainable use of natural, cultural and historical heritage of the cross-border area adjacent to Curonian and Vistula lagoons;

– Curonian and Vistula lagoons – perspectives for environment-protection in international cooperation.

According to the students, the most interesting lectures were given by Dr. Nikolay Belov, Associate Professor of the geography Department of the IKBFU on the use of GIS technologies. Students were interested in the possibilities of laser scanning in search for archaeological objects and objects of the cultural and natural heritage for their future detailed investigations aimed at preservation and reconstruction.

The method is non-invasive and hence, sustainable. "Do as you preach," be mindful of the nature and show it in your teaching.

The final event took place at the Curonian Spit, where a lecture on the Curonian Spit was delivered, and the students visited the major natural heritage objects of the main national park of the Kaliningrad, such as "The Ef height" and the "Dancing forest." After that, the students attended a lecture at the ornithological

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[3] Newsletter #1 on the results of the CROSSROADS 2.0 Project: www.kantiana.ru/crossroads2/newsletter.pdf [access: 18.11.2016].

[4] Newsletter #2 on the results of the CROSSROADS 2.0 Project: www.kantiana.ru/crossroads2/newsletter_2.pdf [access: 18.11.2016].

station "Fringilla" and witnessed a unique event, a single-time trapping of thousands of dragonflies intended for bird feeding. This type of lecturing , changing the teaching boundaries, provides feasibility and participatory support to the theoretical material. It can be argued that it bridges the existing gap between theory and its application in the minds of the students. At the end of the first part of the courses students presented their homework, their ideas of Projects for a creative use of the heritage objects. Fifteen creative ideas were presented. During the next two parts of the courses, students developed these ideas and presented the Projects for implementing their ideas.

This way another aspect of ESD was approached, that of entrepreneurship and creativity development.

The above process shows a multi-tier approach to ESD, starting from the EE maxims of awareness, responsibility, etc., basically to promoting sustainable trans-border social structures, that take care of both the present and the future generations.

The second part of the course was held in Klaipeda, at Klaipeda University (Project partner), with the same students from the partner countries. Here the second international student seminar on sustainable use of cultural and historical heritage of cross-border lagoon area of the Curonian and Vistula lagoons to promote tourism took place. It was attended by groups of students from Klaipeda, Gdansk and Kaliningrad. During the seminar, students attended lectures of teachers from Lithuania covering interesting issues and historical facts about culture and history of the territories where we are living now.

The involvement of lecturers from three countries underscores the trans-border aspect of the Project, reflecting the universal character of sustainability issues.

"Participants of the workshop sought to unite the past and the future of the region, recalling the history of these places and the culture of the peoples who inhabited this territory, as well as offering their ideas for conservation and sustainable use of the cultural heritage of these areas" – says Vera Popova, 5-year student of the Institute for Environmental Management, Spatial Development and Urban Planning, I. Kant University.

On-site lectures were arranged for students on the mainland coast of the Curonian Lagoon, followed by sight-seeing tours of the old town of Klaipeda. Alexander Danchenkov, a 4th-year student of the Institute for Environmental Management, Spatial Development and Urban Planning, said, "It is very pleasant to see such an interesting Project implemented by our university – I. Kant BFU, the way you can learn many interesting things about the place where we live , the territory of the South- Eastern Baltic, – and successfully work with students from the neighbouring countries."

On the November, 12-16th 2013 the final international student seminar "Creative use of natural, historical and cultural heritage of the territory of the

Curonian and Vistula lagoons with the view of educational and cultural tourism development: problems, sustainability and prospects" was held in Gdansk. The event took place on the premises of the Polish Maritime Museum in Gdansk (Project partner). Summing up, Dr. Elena Kropinova, Project coordinator, noted the innovative character of the projects presented by the students, in particular the integrated approach to tourist product development that appeals to different target groups of tourists. "These were Projects created by young people of the region, the proposals focused on active tourism, involvement of natural, cultural and historical heritage into sustainable tourist use. As they have been developed by young people, the young are interested in them, they will certainly be highly-sought for by the young! Lecturers from all three countries have done a great job in shaping the seminar participants' perception of integrity of the South-Eastern Baltic as a common cross border tourist area" – said the Project coordinator.

In general, a series of workshops within the framework of the "CROSS-ROADS 2.0" Project allowed the students to learn the basics of strategic planning and sustainable development of the territory in the tourism sector; the participants also learned how to work in international working groups that can serve as a good experience in future professional activities.

The second set of events was different. It involved some direct hands-on application of the theories.

The participants were involved in archaeological excavations in Russia (the area adjacent to Curonian and Vistula lagoons of the Kaliningrad region) and Poland (Olsztyn forest area).

Students from the University of Gdansk, Klaipeda University, I. Kant Baltic Federal University and members of the association "Pruthenia" from Olsztyn took part in excavations on the territory of Poland. The excavations took place in the forest of Olsztyn, at the site of an old Prussian settlement on the bank of the Lyna river. It is assumed that the settlement existed until the 14th century, as the latest findings date back thereto. A lot of pottery, Arab coins indicating that the residents of the settlement carried out active trade, and some cattle bones were discovered. It can be concluded thereupon that cattle breeding was developed in the village. A trip to the castles and Roman Catholic churches of Warmia and Masurian Voivodeship and a horse ride to a nearby agritourism farm were arranged for the participants of the excavations on the weekend . The trips were meant to strengthen the link between sustainability, tourism, heritage, etc. theories with practice.

In Kaliningrad, archaeological excavations were carried out from July 1 to August 7 in the settlement of Mokhovoye (Zelenogradsk district) and the settlement of Ushakovo (Gurievsk district). In Mokhovoe settlement of Zelenogradsk district the archaeological site consists of a complex of archaeological monuments of the Viking Age in the area of Kaup. The diggings were carried

out by Polish and Lithuanian students who major in archaeology and history. They worked with shovel and brush with a keen interest, learning the nuances of Russian archaeological field methods. Three pits covering the area of 84 m² were allocated for diggings (in accordance with the number of countries participating in the Project) on the territory of the burial ground of Small Kaup. At the "Russian" and "Lithuanian" excavations archaeologists found Prussian burials of the 11th century. The "Polish" pit, to the delight of Gdansk students, revealed the remains of an Estians' burial of the 5th century. As for the settlement of Ushakovo in Gurievsk district, the goal of the expedition was to study a new coastal culture monument discovered in 2012. Settlements of this culture are located on the banks of the Vistula and Curonian Lagoons and are dated 3rd c. BC. The study of the settlements of coastal culture tribes is one of the priority research trends in the Baltic. It is assumed that the coastal culture tribes laid the foundations for the development of the Balts, and, according to certain hypotheses, also to the Slavs. No matter how amazing it is, but at the lowest level of the cultural layer archaeologists participating in the excavations found earlier materials relating to the culture of funnel beakers (CFB). Tribes of CFB in the IV c. BC settled on the vast territory from the Netherlands to the Western Ukraine. Everywhere they preferred to be engaged in farming and cattle breeding. Within the Baltic Region their monuments had not been previously known, with the exception of only a few findingsThe participants had an opportunity to find out for themselves that the cultural and ethnic genesis of Baltic peoples was of a more complex character.

Another outcome of the excavations became evident in three diploma papers defended by the students who attended the excavations.[5]

The excavations were carried out in the free time of the students, hence underscoring the importance of non-stop ESD.

This type of activities has taught the students to cherish the indigenous culture of the region. It showed the necessity to work together to make a more accurate analysis of the facts, to develop adequate theories and to work together to preserve the cultural heritage. All this falls within the best concepts of EE and ESD [Kopnina 2012a].

A different group of participants was involved in the third round of educational activities.

A training course on "The past and present of South-Eastern Baltic" for fifty tour guides and museum employees from Poland, Lithuania and the Kaliningrad region of Russia was arranged at Immanuel Kant Baltic Federal University. The participants attended the lectures delivered by leading specialists of I. Kant BFU on history, culture, ethnology, natural and cultural landscapes, modern socio-

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[5]  Newsletter #3 on the results of the CROSSROADS 2.0 Project: www.kantiana.ru/crossroads2/newsletter_3.pdf [access: 18.11.2016].

economic development of the South-Eastern Baltic and other issues relevant for potential tourists. The course also included educational visits to the coastal areas of the Kaliningrad region of the Russian Federation, Poland and Lithuania, during which the best tour guides gave a master class on sightseeing tours in the cross-border areas. At the end of the course the participants passed tests and obtained accreditation issued by the Ministry of tourism of the Kaliningrad region, enabling them to carry out excursion activities on the territory of the Kaliningrad region.[6]

In this event the local authorities were involved, thus strengthening the overall potential of the activities.

The expert community also made a great contribution into the future of sustainable tourism in the region by elaboration and issuing the text-book "Natural, Cultural and Historical crossroads of the Baltic." The publication provides guidance to the users in following the sustainability requirements. Hence it reaches out to a still vaster audience.

The text-book is based on the idea of providing reliable information support to the tour guides working in cross-border and transboundary territory outside their native country in the course of supporting transboundary tourist routes in the area adjacent to the Vistula/Kaliningrad and Curonian Lagoon. Application of the information presented in this book will help gain knowledge necessary to obtain accreditation for tour guides working simultaneously on the territory adjacent to the Vistula/Kaliningrad and Curonian Lagoons within the cross-border region represented by municipalities of three states of Lithuania-Poland-Russia [Kropinova, Volkova & Belova 2015: 144].

The uniqueness of the text-book is that it represents historical events and describes the cultural peculiarities of the formation of the cities, that are centres of attraction for tourists, through the eyes of researchers - residents of the region. The materials were prepared using original historical facts, including the ones collected during the work of experts of the Project "Crossroads 2.0." The text-book is intended for practicing guides, students majoring in tourism, as well as for all those who love their land and are interested in what is happening on the other shores of the common lagoons. It can therefore be of use both for work and for leisure-time activities of the population.

The book shapes the sustainability modus operandi for the guides. Working with guests, the guides will keep spreading this world view.

The Project has reached out for even vaster audiences, as over 3,000 people came to spend their free time at three-day mini-festivals "Days of Ancient handicrafts" and educational lessons of live history at the new open-air museum of

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    [6]  Newsletter #1 on the results of the CROSSROADS 2.0 Project: www.kantiana.ru/crossroads2/ newsletter_4.pdf [access: 18.11.2016].

the Viking epoch at the Russian part of the Curonian Spit, and in Ethnographic park in Olsztynek (Pl). Incorporating free-time activities enables the educators to appeal to involuntary memory and to motoric memory in shaping sustainable behaviour habits.

The international festival of historic re-enactment "Days of Ancient Crafts" took place in the open air museum of the Viking Age "Ancient Sambia," created in full accord with sustainability requirements. Over 30 craftsmen from the Kaliningrad region of the Russian Federation and other regions of Russia, Lithuania and Poland presented their arts and crafts to the public during the festival. Within the framework of the mini-festival, guests had an opportnity to learn ancient crafts such as woodcraft, art of candle making, amber jewellery production, cooking according to ancient recipes and pottery. An integral part of the festival was dancing and singing as the ancient inhabitants of the Viking Age. The Project partners also dressed up according to the epoch to greet the visitors and promote this sustainable tourism destination.

In Olsztynek, master classes of ancient handicrafts were organized for 25 children from underprivileged families, 10 from Russia and 15 from Poland. There were 4 days of engaging master-classes in different ancient handicrafts and cooking for children 9-11 years-old children. It was the first event of such format and topic, and children were very glad, as they had a chance to live four days in old Prussian time, to practice sustainable living. Knowing the heritage, you learn to value and preserve it.

The Project has proven that ESD is a life-long learning process, so it has to start at a very fragile age. It also presupposes lack of discrimination on any grounds [Education for Sustainable Development Lens 2010].

Yet again, free-time activities were incorporated into the ESD process.

# 4. Conclusions

The results of integrating different types of formal, non-formal and informal education by the Project analysed in the present article can be clearly qualified as "based on local needs, perceptions and conditions, but acknowledges that fulfilling local needs often has international effects and consequences; it promotes a shift from mental models to sustainability practices through which these mental models and concepts are explored and reviewed. It includes entrepreneurship and creativity development" [Education for Sustainable Development Lens 2010: 17].

Notwithstanding the limitations set by the format of a Project, "CROSSROADS 2.0" has made a solid contribution into the ESD development in the region, in ascertaining the "quality that provides the values, knowledge, skills

and competencies for sustainable living and participation in society and decent work."[7]

The lectures provided knowledge, the diggings, living in the ancient Sambia, guided tours, etc. made an input into the formation of skills and competencies, while the overall approach of the Project to the tourist destination has contributed to the moulding of sustainability values.

The project has involved representatives of three different cultures. Participating in the events both organizers and the public were also developing intercultural communication skills, empathy, tolerance, respect.

Involving governmental, non-governmental, educational and administrative partners the Project has put into practice the universal responsibility value of sustainable development and ESD.

The combination of different educational and non-educational events into the formal, non-formal and informal activities underscores the holistic approach to ESD.

The life-long character of the ESD was taken care of trough involving participants of different ages, cultures, professional and educational backgrounds.

Another very important result is the practical application of the ESD efforts. Thanks to the new museum and to the educational activities organized within the framework of the Project the promotion of sustainable use of heritage objects became more active on Curonian Spit sites adjacent to the Curonian and Vistula lagoons [Kropinova 2005; Territorial complex scheme... 2004].

Both famous and less known objects, which were not used as tourist attractions, were restored, their further decay was prevented; the infrastructure was created on the territory surrounding these objects, and the objects themselves were included into new tourist routes [The Catalogue of objects... 2009].

All the above proves the high potential of international Projects in the application of ESD at different levels.


# References

Belova A., 2010, Kaliningrad Region as prospective centre for development of ecotourism in the South-East Baltic, *Perspectives Baltic 21*, Series No. 1, 48-50.

Bonn Declaration (UNESCO 2009). Ministerial Round Table on Quality Education, UNESCO, 2003, http://unesdoc.unesco.org/images/0018/001887/188799e.pdf. [access: 18.11.2016].

Education for Sustainable Development Lens: A Policy and Practice Review Tool, 2010, *Education for Sustainable Development in Action Learning&Training Tools*, no. 2.

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[7]  Bonn Declaration (UNESCO 2009): http://unesdoc.unesco.org/images/0018/001887/188799e.pdf [access: 18.11.2016]. Ministerial Round Table on Quality Education (UNESCO 2003: 1).

Kopnina H., 2012a, Education for sustainable development (ESD): the turn away from 'environment' in environmental education?, *Environmental Education Research*, 18(5), 699-717.

Kopnina H., 2012b, Revisiting education for sustainable development (ESD): examining anthropocentric bias through the transition of environmental education to ESD, *Sustainable Development*, http://onlinelibrary.wiley.com/doi/10.1002/sd.529/abstract [access: 18.11.2016].

Kopnina H., Meijers F., 2014, Education for sustainable development (ESD): exploring theoretical and practical challenges, *International Journal of Sustainability in Higher Education*, 15(2),188-207.

Kropinova E.G., 2005, Regionalno-ekonomicheskiy analiz formirovaniya territorialnykh rekreatsionnykh sistem, SPb.: SPbSU Publishing House (in Russian).

Kropinova E.G., Volkova I.I., Belova A.V., 2015, *Natural, Historical and Cultural Crossroads of Baltic*, Kaliningrad: Pictorica Publisher.

Newsletter #1 on the results of the CROSSROADS 2.0 Project, www.kantiana.ru/crossroads2/newsletter.pdf [access: 18.11.2016].

Newsletter #2 on the results of the CROSSROADS 2.0 Project, www.kantiana.ru/crossroads2/newsletter_2.pdf [access: 18.11.2016].

Newsletter #3 on the results of the CROSSROADS 2.0 Project, www.kantiana.ru/crossroads2/newsletter_3.pdf [access: 18.11.2016].

Newsletter #4 on the results of the CROSSROADS 2.0 Project, www.kantiana.ru/crossroads2/newsletter_4.pdf [access: 18.11.2016].

Newsletter #5 on the results of the CROSSROADS 2.0 Project, www.kantiana.ru/crossroads2/newsletter_5.pdf [access: 18.11.2016].

Schroter D., 2010, *Sustainability Evaluation Checklist*, Kalamazoo, MI: Western Michigan University, www.wmich.edu/evalctr/wp-content/uploads/2010/06/SEC-revised1.pdf [access: 18.11.2016].

Territorial complex scheme of spatial development and town-planning of Kaliningrad region up to 2030 [Территориальная комплексная оценка градостроительного планирования развития территории Калининградской области на период до 2030 г. (утверждена Постановлением Губернатора Калининградской области № 600 от 14.12.2004 г.)].

The Target Programme "Development of the Kaliningrad region up to 2020".

The Catalogue of objects of historical and cultural heritage of the territory of Kaliningrad region adjacent to the Curonian and Vistula lagoons [Каталог объектов историко-культурного наследия, расположенных на территории Калининградской области, прилегающей к Куршскому и Вислинскому заливам], 2009, Kaliningrad: IKBFU Publisher.

UNEP and UNESCO, 1976, *The Belgrade Charter*, www.medies.net/_uploaded_files/TheBelgradeCharter.pdf [access: 18.11.2016].

UNESCO, 2005, *United Nations decade of education for sustainable development (2005-2014)*, Framework for the International Implementation Scheme, 32 C/INF.9, http://unesdoc.unesco.org/images/0013/001311/131163e.pdf [access: 18.11.2016].

Wals A.E.J., 2007, *Social Learning: Towards a Sustainable World*, Wageningen: Wageningen Academic Publishers.

Wals A.E.J., 2009, *Review of Contexts and Structures for Education for Sustainable Development*, Paris: UNESCO.

World Declaration on Education for All: Meeting Basic Learning Needs, World Conference on Education for All, Jomtien, Thailand, March 1990. www.un-documents.net/jomtien.htm [access: 18.11.2016].

www.park-kosa.ru [access: 18.11.2016].

## Edukacja dla zrównoważonego rozwoju jako pozytywny efekt uboczny działań międzynarodowych na przykładzie projektu CROSSROADS 2.0

**Streszczenie.** Edukacja dla zrównoważonego rozwoju (EZR) to wyzwanie podejmowane na różne sposoby przez wydziały uczelni wyższych, nauczycieli szkół średnich oraz temat wielu badań. Do tej pory jednak w literaturze nie poświęcono wystarczająco dużo uwagi kwestii wkładu międzynarodowych projektów uczelnianych do systemu EZR. Niniejszy artykuł opisuje studia przypadków i analizuję od strony teoretycznej rolę, jaką odgrywają międzynarodowe projekty współpracy międzyuczelnianej w praktycznej integracji działań lekcyjnych i pozalekcyjnych w ramach EZR. Takie podejście do wdrażania edukacji dla zrównoważonego rozwoju przyjęto w rejonie kaliningradzkim, jednym z transgranicznych regionów nadbałtyckich. Badanie obejmuje wszystkie trzy wymiary trwałego rozwoju, tzn. ekologiczny, ekonomiczny i społeczny, oraz poprawę środowiska regionalnego. W artykule omówiono akty prawne władz federalnych i regionalnych oraz przeszkody i możliwości rozwoju zintegrowanego podejścia do EZR. Tytułowy projekt „Zatoki jako miejsca spotkań turystów i mieszkańców krajów południowo-wschodniego regionu Bałtyku: od czasów historycznych do teraźniejszości" jest realizowany przez trzy kraje nadbałtyckie i stanowi kontynuację projektu CROSSROADS. Wyniki projektu potwierdzają wnioski wynikające z rozważań teoretycznych na temat istniejących podejść w tej dziedzinie.

**Słowa kluczowe:** trwały rozwój, edukacja dla zrównoważonego rozwoju, współpraca transgraniczna, studium przypadku, podejście zintegrowane

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# Preparation
# of Future Primary School Teachers
# to Implement Ideas
# of Sustainable Development
# in Maths Classes

**Abstract.** Sustainable development in education is the basis of sustainable development of society. To ensure sustainable development in education, its principles need to be implemented in all training courses. Higher pedagogical education should provide training in designing and teaching such courses. At our universities, future primary school teachers are trained to keep their maths lessons in line with the principles of sustainable development in three key areas. The first area relates to the development of pupils' social involvement through their acquisition of intellectual and practical skills of using maths. The second area concerns pupils' relationship with their natural and cultural environment. Future teachers are trained to design tasks that stimulate pupils' emotional engagement and caring attitude. The third area that future teachers are trained to target is pupils' economic and financial competence. Teaching skills in all these areas can be developed effectively through the case method.

**Keywords:** education for sustainable development, methods of teaching maths, primary school teachers, case method of teaching, modelling skills

## 1. Introduction

The sustainable development strategy focuses on three main aspects: development of a highly intelligent person capable of solving creative problems; preservation of the natural and cultural human environment; formation of economic

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thinking and prudent use of the natural and financial resources [*Ustoychivoe razvitie* 2011]. The National Strategy for Sustainable Socio-Economic Development of the Republic of Belarus Until 2030 emphasizes the importance of sustainable development in educational processes [Natsionalnaya strategia 2015].

To implement the idea of sustainable development in the process of training primary school teachers it is important to develop specific teaching methods. Mathematics Teaching Methodology is one of the leading subjects in the curricula of the faculties preparing primary school teachers. The effectiveness of the development of students' competence to form appreciating attitude to the environment in children largely depends on close connection between this subject and the ideas of sustainable development.

The Mathematics school course offers a number of opportunities to educate an individual in accordance with the ideas of sustainable development:

– mathematics can facilitate development of intellectual skills vital to solve creative problems, to explore and preserve the human environment. Modelling plays a special part in the system of intellectual abilities, being both mathematical and intellectual ability. The experience of modelling is a valuable skill opening for the person the possibilities of independent cognition and continuing the process of education during the life [Gadzaova, Murauyeva & Urban 2015];

– through the content of verbal arithmetic problems children can get acquainted with quantitative information that reflects the real environmental problems of the region and the cultural heritage of their native land;

– verbal arithmetic problems may contribute to the formation of pupils' economic thinking and prudent attitude to the natural resources and to the family budget alike.

To enable a teacher to fully exploit the potential of mathematics to implement the ideas of sustainable development in the classroom, the process of university training must embody active methods of teaching students to develop the corresponding mathematical tasks for children. The experience of teaching Mathematics Methodology at the Maxim Tank Belarusian State Pedagogical University and the Yanka Kupala State University of Grodno proves that teaching students to develop such tasks becomes more efficient when using the case method.

## 2. Formation of intellectual and practical activity by means of mathematics

The development of intellectual and practical activity is based on human ability to analyze and build models of natural, social and economic processes. The ability to build models is the basis of a creative approach to solving real problems,

because, according to G. Altshuller, the transition from a practical problem to its model makes it easier for a researcher to identify the physical contradiction constituting the core of the problem situation [Altshuller 2011].

Modelling in teaching mathematics is seen as a didactic "projection" of the method of mathematical modelling, the essence of which is a cyclical process of solving real problems by mathematical means. In the most general form, the process of mathematical modelling can be presented as a mathematisation cycle offered by J. de Lange: real-word problem – mathematical problem – mathematical solution – real solution [De Lange 2006].

Understanding the nature of the process of mathematical modelling was the basis for the didactic studies on the problem of forming pupils' ability to model. Despite the widespread view, according to which mathematical modelling should be taught in middle and high school [Galbraith & Stillman 2001], several researchers note that some elements of mathematical modelling may be available and useful in teaching junior schoolchildren [Lehrer & Schauble 2003; English & Watters 2005].

The problem of using models in the primary mathematical education is traditionally linked to visual representations due to the specifics of the mental processes in children of this age group. This is why the manuals for grades 1-4 are normally provided with many illustrations. However, not every visual representation contributes to a better comprehension of mathematical concepts, but models do. One of the first mathematicians to raise the question about the problem of using visual (graphical) models in teaching mathematics was J.E. Littlewood [1953], but the concept of visualization got widespread in teaching mathematics only at the end of XX – beginning of XXI century [works by Bartolini Bussi & Mariotti 2008; Giaquinto 2007; Goldin 2002; Reznik 2012, etc.].

A number of studies underline that for the understanding of mathematical ideas the importance lies not in the visualization itself, but rather in "flexible and competent translation back and forth between visual and analytic representations of the same situation" [Arcavi 2003: 235]. Therefore, internal representations of mathematical concepts that support the understanding can be of different nature, because they are the mental configurations of a personality [Goldin & Caput 1996].

Of course, visual representations of key concepts of mathematics are very important for the formation of mathematical thinking, especially in the early school years, but they can and should also be verbal, notational, strategic or even affective [Goldin 1998].

Thus, in the process of searching a solution to a problem, beside visual models children learn to use verbal and symbolic models of the problem. The natural language is used to construct verbal models and symbolic models use the language of mathematical symbols. Ability to present the same idea by means of

different languages (visual, verbal or symbolic representation) promotes the formation of representational fluency [Goldin 2002] and is an important social skill of the modern individual [English & Watters 2005].

The set of math's educational materials, based on the ideas of using modeling as an instrument of problem solving, was launched in the Republic of Belarus in 2011. The set of books consists of a textbook, tutor's manual, writing book, test book, writing book for challenging tasks and digital educational resource. Figure 1 shows an example of visual, verbal and symbolic models of verbal problems in Grade 2 Mathematics Textbook [Muravyova & Urban 2016], and figure 2 – examples of models made by children.
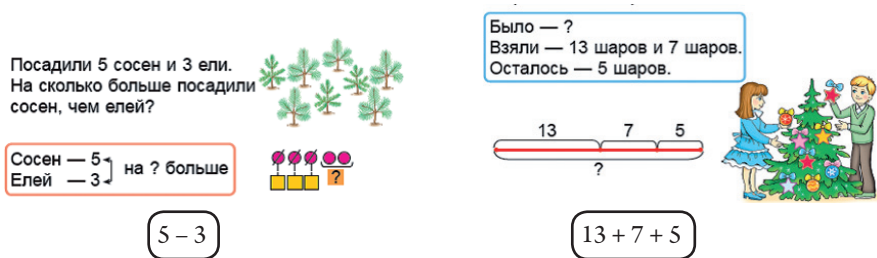


Figure 1. Example of visual, verbal and symbolic models of verbal problems in the Belarusian teaching materials in Mathematics

Source: Muravyeva & Urban 2016.
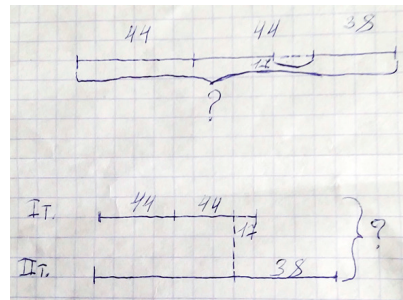


Figure 2. Examples of models made by pupils

Source: own elaboration (photo by M. Sharapa and J. Talai).

Methodical preparation of students in this area includes, first, training students to use models in the search for solutions of verbal problems, and second, development of the competence of future teachers to form the modelling ability in primary school children.

# 3. Formation of respect
# for the natural and cultural environment

An arithmetic problem can have a rich educational potential manifested in a story contained in its text. At the Maxim Tank Belarusian State Pedagogical University and the Yanka Kupala State University of Grodno the practical preparation of future primary school teachers includes methodical tasks on developing verbal arithmetic problems with cultural and environmental content. These tasks help to enhance pupils' positive and caring attitude to their natural and cultural environment. Verbal arithmetic problems developed by students may:

- highlight the implications of the global climate change.
- cultivate love to the nature and culture of Belarus,
- raise awareness about the importance of the nature protection in Belarus,
- motivate children to contribute to the development of Belarusian culture.

The following are examples of verbal arithmetic problems developed by students:

1) The area of Belarus is $207\,600$ km². One tenth of the surface is covered by swamps. The area of swamps taken under protection is about one-tenth of their total area. In the future, this number will increase by a factor of 3. How many square kilometres of Belarusian swamps will be subject to protection?

2) In 2009, a cycling path going through the whole city was built in Minsk. The length of the cycling path is 26 km 800 m.

- How long would father's return trip on the path take if his speed is $13\,400$ m/h?

- How many litres of petrol would father need if he was to cover this distance by car, considering that the car consumes 10 litres per 107 km 200 m?

3) Niasvizh Castle was built in the late 16th century. The restoration of the castle began in 2004, and in 2012 the restoration was completed. How many years did it take to restore the castle? How many centuries have passed from the construction of the castle until the completion of its restoration in 2012?

# 4. Formation
# of economic and financial literacy

In respect to formation of economic and financial competence, future teachers can create two types of project problems:

- projects showing children the need to limit the consumption of the natural resources,

– projects teaching children to use the family budget efficiently.

The following are examples of projects that can be offered to primary school pupils.

1) Project "Limit the Consumption of the Natural Resources"

Note how much time you spend brushing your teeth in the morning. Count how many litres of water run from the tap during this time. Calculate how many litres of water can be saved per year by using a glass when brushing teeth.

2) Project "Family Budget"

Your mobile provider offers two rate plans. The first suggests paying 1 rouble 20 kopecks per 5 minutes. The second is 7 kopecks per 10 seconds. Which rate plan is a better deal for your family budget?

3) Project "Fighting Air Pollution"

It is known that a car emits into the atmosphere 20 g of carbon monoxide per 1 km and a truck emits 170 g per 1 km. One tree processes 2 kg of carbon monoxide in 1 hour on average. How many vehicles pass by your house in 1 hour and how many trees must be planted along 1 km to clear the air of carbon monoxide?

4) Project "Family Car"

Does your family own a car? How many kilometres a week does your car run? How much money does your family spend on the car per week if the car consumes about 15 litres of gasoline per 100 km and the price of 1 litre of gasoline is 1 rouble 10 kopecks? How much money can the family save if it chose to use public transport or bicycles during that period?

# 5. Application of the case method in teaching students

The case method has long established itself as one of the most effective teaching techniques for adults, especially in the field of economics and business education. The case method is based on the holistic review and analysis of real life situations (people, events, decisions, etc.) [Thomas 2011]. The case method aims to encourage pupils to find a way to overcome the difficulties faced by the main character(s) of the case [Leenders & Erskine 1989]. The generation of the ways to solve the problem presented in the case is a particularly valuable component of the process of working with cases [Woodside 2010].

Several studies have underlined the effectiveness of the case method for the realization of the ideas of sustainable development in the university training of students [Kostyuchenko & Smolennikov 2016]. Using the basic ideas of the case method in the mathematical training of primary school teachers seems to be not only possible but also feasible [Urban 2003].

Caselets, or short cases, are a special variant of cases that a teacher can use in the classroom. Such cases feature small size (up to three pages) so they can be used for practical lessons with students without special preparation at home. The studies note that the use of caselets is now becoming a very popular means of training as it is easier to adapt a short case to a particular topic, audience or a particular teaching style [Selvam, Babu & Raja 2006]. The experience of using caselets in teaching shows that in spite of their small volume caselets, as well as a "big" case, allow students to practice applying theoretical ideas to solving real life problems [Gladkikh 2008].

To realize the ideas of sustainable development in the course of Mathematics Teaching Methodology it is important to offer students specially designed cases. Such cases should be based on the following principles:

– the principle of an underlying **verbal arithmetic problem**. In accordance with this principle, the central element of the case should be a verbal arithmetic problem with the content allowing to reveal the challenges of sustainable development;

– the **poly-directional** principle, which involves the organization of several thematic working groups of students to analyze the proposed case from different points of view (mathematical aspect, cultural and environmental aspect, economic aspect);

– the principle of **minimalism**, according to which the case should be short (no more than one page text), which allows its successful analysis by students during one practical lesson lasting 90 minutes.

## 6. Practical application of the case method in the process of training students to conduct mathematics lessons in primary school

The Maxim Tank Belarusian State Pedagogical University and the Yanka Kupala State University of Grodno have developed a series of cases (caselets) for practical activities with students, which associate the formation of methodological and mathematical competence of future teachers with the implementation of the ideas of sustainable development. Here is one of the cases developed for practical activities on the topic "Methods of Working on Problems with Proportionate Quantities". The topic was chosen due to the fact that problems with proportional quantities describe many processes in the environment and make it possible to organize purposeful work on formation of the initial concepts of functional relationships of the quantities [Gadzaova 2014].

For the development of cases we applied the case structure recommended by the scientific literature [Gladkikh 2005], which usually contains the following sections:

1. Case text.
2. Questions for discussion.
3. Applications.
4. Teaching notes.

In this article, we do not intend to provide methodical guidelines for the work with cases (teaching notes), thus, only a brief description of the three main sections will be presented: case text, questions for discussion and applications.

**Case Name**: Designing a lesson on the topic "Solving Problems with Proportional Quantities"

**Case Content:** During teaching practice at school a student held a mathematics lesson in the fourth grade. The list of the lesson goals included the following: to consolidate the ability to solve problems with the 4th proportional by the method of relationships; to consolidate the ability to solve problems in the determination of the price, quantity and value; to cultivate respect for the natural resources; to teach to plan the family budget. To realize these goals the trainee planned to work on two verbal problems:

– A family of three people consumes 285 litres of water per day. How much water is consumed per day by a family of four, if water consumption per person is almost equal?

– Father paid 24 roubles for 8 m of wire. Is 5 roubles enough for father to buy other 4 m of the wire?

During self-analysis the trainee stated that she was satisfied with the lesson because the children had time to write the solutions of both problems in their notebooks and the contents of the problems helped to achieve the educational goals of the lesson. However, the students and teachers who attended the lesson thought that the lesson goals were not achieved. During the discussion of the lesson several comments were made.

*Comment One.* The work on the problems did not correspond to the consolidation stage; the children did not show independence. The solution of the problem through relationships was not discussed; the potential of the model was not used to find the solution of the problem through relationships. The first problem could not be solved in two ways, and when solving the second problem the method of relationships was not discussed.

*Comment Two.* Educational potential of the content of the problem to form in children the respect for the Belarusian natural resources was not used. The teacher did not hold any discussion about the importance of conservation of freshwater reservoirs in the country and around the world and did not focus children's attention to the problem of rational water consumption.

*Comment Three.* The lesson did reveal the relation between saving the natural resources and planning the family budget, the texts of the problems were not correlated with the social problems of the family.

The student was offered to prepare and hold another lesson taking into account the comments made.

**Questions for discussion**

1. How to organize the work on the proposed tasks to form the understanding of the functional relationships of values by means of modeling? What methodical techniques will you use at the stage of searching solutions to the problem? What changes must be made in the text of the first problem to allow two ways of solving by the arithmetic method? Can you offer any other ways to organize creative work on the problem after its solution? Prepare a presentation of the group ideas.

2. How to organize the work on the first task to contribute to the development of respect for the nature of the native land? What methodical techniques will you recommend to apply? What environmental information will you need? Prepare a presentation of the group ideas.

3. How to organize the work on the proposed tasks to create conditions for the realization of the goal of building skills of rational use of the family budget? What methodical techniques do you recommend to apply? How can you work on the problem after its solution? Prepare a presentation of the group ideas.

**Applications**

*Article 1.*

Provision of clean drinking water is one of the major social and environmental challenges, the solution of which aims at the preservation of human health. The main source of drinking water for the population of Belarus is groundwater, and in Minsk and Grodno water from surface sources is used for these purposes. Industrial enterprises and agricultural complexes also require significant water consumption.

Water quality depends on human activities. Industrial wastes, sewage from agricultural and cattle-breeding complexes bring to the rivers various harmful substances (oil products, metals, fertilizers, etc.) that pollute the water sources. The condition of water also depends on the proximity to major population centres and the state of the treatment plants. E.g., 2 liters of engine oil discharged into the river will contaminate the volume of water equal to 5 swimming pools. Thus, the Svisloch River is one of the most polluted rivers in Belarus, and the Neman River is one of the cleanest rivers in our country.

*Article 2.*

The needs of the modern society require a lot of water. Belarus has sufficient water, but at the moment 22 countries in the world already experience a chronic

shortage of water, and by 2025 their number will increase to 32 countries. This means that water intake per capita in these countries amounts to 1 000 000 liters per year while the standard rate is 1 800 000 liters per year.

Drinking water consumption per capita in cities ranges from 140 liters to 370 liters per day. Due to the installation of individual water meters in Belarus, the population tends to reduce water consumption. 1000 liters of water cost about 47 kopecks at the consumption of up to 140 liters per day per person and 69 kopecks at the consumption in excess of 140 liters per day per person.

During one day an average person uses water for: hand washing – 8 liters; tooth brushing – 9 liters, if the tap is not closed; washing fruit under running water – 15 liters; taking a shower – 15-20 liters per minute; taking a bath – 150 liters; laundry – 130-150 liters at a time.

Having read the case, the students were divided into three groups in accordance with the notes provided in the text. One group analyzed the situation from the point of view of achieving the mathematical objectives of the lesson, the second group considered the cultural and environmental aspects, and the third group reviewed it from the perspective of the family budget. The groups worked for 30 minutes and then presented their solutions. Each presentation lasted about 10 minutes. After presentations of the group solutions a 30 minute group discussion was held, during which the students came to the conclusion about the possibility and feasibility of combining methodical and socially important educational ideas in teaching to solve verbal arithmetic problems at a mathematics lesson.

# 7. Conclusion

To achieve the goals of sustainable development it is necessary to represent its ideas both in the content and in the teaching methods at the different levels of education. Thus, future teachers must be trained taking into account the current social, environmental and economic situation.

Education for sustainable development is associated with a change in educational approaches. For teachers – from the transfer of knowledge to the creation of conditions for active learning and gaining practical skills. For students – from passive learning of information to active search, critical comprehension and use in practice, to dialogue and action.

Teaching modelling should be part of the preparation of future primary school teachers, because the ability to build models of different types (visual, verbal and symbolic) is an important social skill and intellectual ability of a modern person. Developing and solving verbal problems with cultural, environmental

and economic content contributes to the education of the individual for the purposes of sustainable development.

One of the methods aimed at the implementation of the idea of sustainable development is the case method. This is due to the orientation of education to the development of personality, values and attitude to life, mastering the skills to work with information in the process of formation of professional competence.

The special character of the content and organization of work with the cases, that allow to implement the idea of sustainable development in preparation of future primary school teachers to teach mathematics, is reflected in the following principles: the principle of an underlying verbal arithmetic problem, the principle of poly-directional thematic working groups of students, and the principle of minimalism.

The conducted methodical work has shown that the means of the subject Mathematics Teaching Methodology can have a positive impact on the achievement of a number of key goals of education for sustainable development: to form general educational intellectual and practical skills, to master the subject content with a focus on the formation of attitudes and the development of critical thinking; to enhance economic literacy; to develop responsibility for the preservation of the natural and cultural environment.

# References

Altshuller G., 2011, *Nayti ideyu: Vvedenie v TRIZ – teoriyu resheniya izobretatelskikh zadach* [*Find an Idea: Introduction to TSIT – the Theory of Solving Inventive Tasks*], Moscow: Alpina Publishers.

Arcavi A., 2003, The Role of Visual Representations in the Learning of Mathematics. *Educational Studies in Mathematics*, 52, 215-241.

Bartolini Bussi M.G., Mariotti M.A., 2008, Semiotic Mediation in the Mathematics Classroom: Artifacts and Signs After a Vygotskian Perspective, in *Handbook of International Research in Mathematics Education*, eds. L.D. English, D. Kirshner, Mahwah, NJ: Lawrence Erlbaum.

English L.D., Watters J.J., 2005, Mathematical Modelling with 9-Year-Olds, *Proceedings of the 29th Conference of the International Group for the Psychology of Mathematics Education*, 2, 297-304.

Gadzaova S., 2014, Podgotovka studentov k osushchestvleniyu funktsionalnoy propedevtiki v nachalnom kurse matematiki sredstvami modelirovaniya [Preparing Students for the Implementation of the Functional Propaedeutics in the Introductory Course of Mathematics by Means of Modeling], *Problemy wczesnej edukacji. Issues in Early Education. Dziecko w świecie liczb i komputerów*, Część 1, 4(23), 77-84.

Gadzaova S., Muravyova H., Urban M., 2015, The Role of the Set of Educational Materials for Teaching Mathematics in Primary School in the Application of the Ideas of

Sustainable Development, *Pathways to the Future: Education for Sustainable Development: Proceedings of International Conference*, 129.

Galbraith P., Stillman G., 2001, Assumptions and Context: Pursuing Their Role in Modeling Activity, *Modeling and Mathematics Education*, 9, 300-310.

Giaquinto M., 2007, *Visual Thinking in Mathematics. An Epistemological Study*, Oxford: Oxford University Press.

Gladkikh I.V., 2005, Metodicheskie rekomendatsii po razrabotke uchebnykh keysov [Methodical Recommendations for Development of Educational Cases], *Vestnik of Saint Petersburg University*, 8(2), 169-194.

Gladkikh I.V., 2008, Keysy "bolshie" i "malenkie" ["Big" and "Small" Cases], *Vestnik of Saint Petersburg University*, 8(1), 156-159.

Goldin G.A., 1998, Representational Systems, Learning and Problem Solving in Mathematics, *Journal of Mathematical Behavior*, 17(2), 137-165.

Goldin G.A., 2002, Representation in Mathematical Learning and Problem Solving, in *Handbook of International Research in Mathematics Education*, ed. L.D. English, Mahwah, NJ: Lawrence Erlbaum.

Goldin G.A., Kaput, J.J., 1996, A Joint Perspective on the Idea of Representation in Learning and Doing Mathematics, in *Theories of Mathematical Learning*, eds. L. Steffe, P. Nesher, Mahwah, NJ: Lawrence Erlbaum.

Kostyuchenko N., Smolennikov D., 2016, Active Teaching Methods in Education for Sustainability as Applied in Good Practices of Local Communities, *Studia Periegetica*, 1(15), 145-149, https://wydawnictwo.wsb.pl/sites/www.wydawnictwo.wsb.pl/files/czasopisma-tresc/Studia P_15_net.pdf [access: 10.12.2016].

Lange J. de, 2006, Mathematical Literacy for Living from OECD-PISA Perspective, *Tsukuba Journal of Educational Study in Mathematics*, 25, 13-37.

Leenders M.R., Erskine J.A. , 1989, Case Research: The Case Writing Process, *Research and Publications Division: School of Business Administration*, Ontario: University of Western Ontario.

Lehrer R., Schauble L., 2003, Origins and Evolution of Model-Based Reasoning in Mathematics and Science, in *Beyond Constructivism: Models and Modeling Perspectives on Mathematics Problem Solving, Learning, and Teaching*, eds. R. Lesh, H.M. Doerr, Mahwah, NJ: Lawrence Erlbaum.

Littlewood J.E., 1953, *A Mathematician's Miscellany*, London: Methuen and Co.

Muravyova G.L., Urban M.A., 2016, *Matematika: uchebnoe posobie dla 2-go klassa [Mathematics: Textbook for Grade 2]*. Part 1, Minsk: National Institute of Education.

Natsionalnaya strategia ustoychivogo sotsialno-economicheskogo razvitia Respubliki Belarus na period do 2030 goda [The National Strategy for Sustainable Socio-Economic Development of the Republic of Belarus Until 2030], 2015, *Economic Bulletin of the Economic Research Institute of the Ministry of Economy of the Republic of Belarus*, 4(214), www.economy.gov.by/ru/macroeconomy/nacionalnaya-strategiya [access: 12.12.2016].

Reznik N.A., 2012, *Vizualnoe myshlenie v obuchenii. Metodicheskie osnovy obuchenia matematike s ispolzovaniem sredstv razvitia vizualnogo myshlenia [Visual Thinking in*

*Education. Methodical Framework of Teaching Mathematics Using the Means for the Development of Visual Thinking*], Saarbrucken: Lambert Academic Publishing.

Selvam M., Babu M., Raja M., 2006, Caselets Teaching in Business Education, *SMART Journal of Business Management Studies*, 2(2), 70-72.

Thomas G., 2011, A Typology for the Case Study in Social Science Following a Review of Definition, Discourse And Structure, *Qualitative Inquiry*, 17(6), 511-521.

Urban M., 2003, Obuchenie s pomoshchyu konkretnykh situatsiy [Training Through Specific Situations], *Pachatkovaya Shkola*, 2, 37-39.

*Ustoychivoe razvitie: obshchestvo, obrazovanie, tekhnologia, ekonomika, ekologia* [*Sustainable Development: Society, Education, Technology, Economy, Ecology*], 2011, Materials of the European Workshop, Minsk, http://minsk.mesi.ru/science/conf [access: 1.12.2016].

Woodside A., 2010, *Case Study Research: Theory, Methods and Practice*, Bingley: Emerald Group Publishing.

## Przygotowanie przyszłych nauczycieli szkoły podstawowej do realizacji idei zrównoważonego rozwoju na lekcjach matematyki

**Streszczenie.** Podstawą przejścia do zrównoważonego rozwoju społeczeństwa jest włączenie idei zrównoważonego rozwoju do edukacji. Skuteczność edukacji na rzecz zrównoważonego rozwoju wymaga wdrażania przedmiotowych zagadnień we wszystkich kursach. W ramach wyższej edukacji pedagogicznej niezbędne jest zapewnienie studentom dostępu do wiedzy oraz umiejętności, które pozwolą im zarówno na włączanie zagadnień zrównoważonego rozwoju do nauczanych przedmiotów, jak i na opracowanie odpowiedniego naukowo-metodologicznego wsparcia. Na uniwersytetach białoruskich przygotowanie przyszłych nauczycieli szkół podstawowych do realizacji idei zrównoważonego rozwoju w nauczaniu matematyki odbywa się w trzech obszarach. Pierwszy związany jest z aktywnością społeczną jednostki i obejmuje rozwój intelektualny uczniów oraz nabywanie umiejętności praktycznych za pośrednictwem matematyki do samodzielnego funkcjonowania w społeczeństwie. Drugi to kształcenie umiejętności tworzenia treści zadań matematycznych, które mają rozwijać u dzieci stosunek emocjonalny oraz szacunek wobec środowiska naturalnego i kulturowego. Trzeci obszar metodologicznego przygotowania związany jest z kształtowaniem wiedzy ekonomicznej u dzieci. Wszystkie te obszary mogą być skutecznie rozwijane za pomocą studium przypadku jako metody nauczania studentów.

**Słowa kluczowe:** edukacja dla zrównoważonego rozwoju, metody nauczania matematyki, szkoła podstawowa, umiejętności modelujące, stadium przypadku

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# Teaching Biomonitoring through English

**Abstract.** The aim of this article is to describe how the interdisciplinary approach to teaching English, based on some aspects of content and language integrated learning (CLIL) methodology, is implemented by combining environmental science, sustainable development, and the English language. The paper introduces an English as a Second Language (ESL) course book designed for students of Environmental Monitoring, who study biomonitoring within the framework of an experimental CLIL course. At the end of each topic students present a project which proves their acquisition of professional and language knowledge. As a result, students obtain professional competence in a wide range of skills. More importantly, this goal is achieved without extending the curriculum.

**Keywords**: ESL, biomonitoring, education for sustainable development, CLIL, ESP

## 1. Introduction

The following article describes the experience of the creating of an ESL course book called "English for biological monitoring" based on some aspects of CLIL methodology and containing the elements of Education for Sustainable Development (ESD) thereby expressing an interdisciplinary approach in education.

The book is designed for the third year students of the faculty of Environmental Monitoring engaged in the experimental course on Biomonitoring. The course is comprised of a set of lectures given in Russian by a subject teacher, a set of practical training carried out in English by the same subject teacher assisting by

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an English teacher, and a supporting ESL course conducted by an English teacher. Thus the presented book is the main textbook for the supporting ESL course. It is obvious that such a supporting course has its unique challenges and therefore they must be reflected in both its contents and language components. The subject matters are provided by the teacher of Biomonitoring according to the themes of the lectures and practical training, and the texts for the course book are collected in collaboration with that subject teacher. The language constituent is focused on the terminology, the use of English; and reading, listening and speaking skills. As the course is at the testing stage the materials are not available on the Internet yet.

## 2. On the question of teaching english for occupational purposes

From the early 1960's, English for Specific Purposes (ESP) has grown to become an important and distinctive part of English Language Teaching (ELT). ESP was defined by Tony Dudley-Evans in particular as designed to meet specific needs of learners or for specific disciplines, making use of underlying methodology and activities of the discipline it serves; aimed at the language appropriate to these activities in terms of grammar, lexis, register, study skills, discourse and genre [Dudley-Evans & St John 1998: 26]

The ESP development has been slow but definite over the past two decades in Belarus. This has led to a growth in English courses included into university curricula aimed at specific disciplines, for example, "English for Ecologists," in place of the more traditional "General English" courses.

The emergence of CLIL in the 90s brought a new matter of argument as to whether ESP and CLIL are different methodologies or two different terms used for the same approach. The core of CLIL is that a content subject, such as environmental science, is learned through the medium of a foreign language and a foreign language, by studying a content-based subject. In other words, a non-language subject is not only taught in a foreign language but also with and through a foreign language.

It is considered that the main difference between ESP and CLIL is that they have a completely different approach to the language studied. In ESP a foreign language is both the content and the means of learning while in CLIL language is seen as just the tool for learning a non-language subject. Another difference lies in the sphere of the objectives and learning outcomes. ESP aims at language-learning objectives whereas CLIL claims that content-learning objectives are either equal or even more important than language-learning ones.

CLIL is now strongly supported by the European Commission and the Council of Europe in order to improve the English teaching and the English language proficiency in students [European Communities 2004; Coyle, Hood & Marsh 2010]. Involving European countries into the Bologna Process engages the standardising of higher education not only in the sphere of internationalising of universities curricular but also in implementing higher education in English.

Belarus joined the Bologna Process in 2015 therefore the need of standardising of the higher education systems has emerged. As a result, universities are trying to internationalise their curricula to facilitate academic cooperation, thus encouraging student mobility. Hence Belarusian university teachers of English are faced with the choice whether to apply CLIL or remain teaching ESP courses in order to meet these needs of standardisation and internationalisation.

## 3. Implementing CLIL technologies

The English teaching process at International Sakharov Environmental Institute of Belarusian State University has been based on the ESP principles for about 25 years. Such ESP courses as "English for ecologists," "English for medical ecology," "English for nuclear safety," etc. has been designed and successfully implemented. But recently in the light of joining the European educational environment the Chair of Foreign Languages has become interested in CLIL technologies. In collaboration with the Chair of Environmental Monitoring and Management it was decided to organise a special experimental course on biomonitoring in the framework of the main course on Environmental Science. The main feature of this biomonitoring course is that the practical training is conducted in English. Thus a course book called "English for biological monitoring" has been developed. Besides the language objectives the book is aimed to prepare the students to this practical training in English. So, going back to CLIL principles, biomonitoring is taught with and through the English language.

## 4. Education for sustainable development in the framework of the course

Working on the book the developer came to the understanding that the interdisciplinary relations of the course concern not only biomonitoring and the English language, but they are also referred to the issues of sustainable development. It is considered that when conducting ESD it should be instilled into the subjects

of the curriculum [HEPS 2004] rather than introduced as a separate one; thus the teachers of different subjects are encouraged to share knowledge and work together on the matters of interest, to make links between their disciplines. Such links have been established in the structure of the course.

It is known that education for sustainable development is the process of equipping students with the knowledge and understanding, skills and attributes needed to work and live in a way that safeguards environmental, social and economic wellbeing, both in the present and for future generations [QAA & HEA 2014].

Although the three components of ESD – social, economic, and environmental – are interdependent, in the framework of ecological education the ecological component of sustainable development appears prevailing. Undoubtedly, impartial information has to be provided on the key issues on climate change, biodiversity loss, and anthropogenic influence on ecosystems allowing comprehension of human vulnerability, responsibility for their future and the future of the planet; but at the same time the purpose of ESD is to motivate and enable the students to change their attitude (as, unfortunately, it commonly can be described as "it's none of my business") and behaviour, to encourage students' learning in this context, and to act deliberately for sustainable development [UNESCO 2012].

## 5. The course book contents

The following describes the interdisciplinary links that have been arranged within the course. The content of the book is divided into 10 units. The first two units concern general matters referring to the main environmental problems and describing biomonitoring as a component of an environmental monitoring system. The subsequent eight units touch upon different species serving as bioindicators of certain kinds of environmental pollution.

The first species under discussion are butterflies as indicators of climate change. The issues of butterfly-host plant interactions, phenological changes of butterflies, their life cycle and how they are influenced by the permanently warming climate are considered as well as the associated biodiversity responses to the changes in the climate [Boggs, Watt & Ehrlich 2003].

Then biomonitoring with macroinvertebrates goes. The monitoring and assessment of the quality of freshwater habitats that are threatened by anthropogenic stressors are considered. The attention is paid to decreasing water quality and the loss of aquatic biodiversity caused by organic and chemical pollution. The maintaining of the sustainable use of waterbodies and therefore the protection of the ecological integrity of freshwater ecosystems are also under discussion.

In the further units, algae, daphnia, and frogs as representatives of water pollution bioindicators are also studied.

Air pollution is recognised by the World Health Organisation as one of the biggest current environmental health issues [WHO 2016]. Hence, lichens and higher plants as air quality bioindicators are the topics of the following units. Not only the questions of lichen sensitivity to nitrogen- and sulpher-containing pollutants and their accumulation patterns are discussed but also the mapping techniques of lichen diversity are studied as it is possible to correlate it – lichen diversity – and air quality because lichen species exhibit varying tolerance levels to air pollution.

And soil pollution can't be set aside as well. The issues of both heavy metal contamination and the use of snails to assess it; and the use of frogs to evaluate in particular soil chemical contamination are touched upon in the light of preservation of human health.

## 6. The course book structure

The structure of each unit is quite the same. Following the aim of preparing the students to practical classes each unit starts with the training of the topical vocabulary in different ways from simple tasks to more and more complicated ones. Special attention is given to the main terms on the topic. Not only are the mere words studied but also their compatibility in phrases and collocations. Grammar is not taught within the course, but the book contains the exercises which help the students realize how the language works. Through these exercises the students learn that one thought may be expressed in different ways, using different grammar structures; and what means of the language should be used to get the goal.

Keeping in mind that CLIL is a content learning the developer introduces certain text work. Fostering reading comprehension is considered highly important in CLIL. Apart from building up extensive reading skills, information manipulation in the post-reading exercises develops general language competence and helps the students expand their vocabulary. In addition the students get acquainted with how the material they study at the lectures conducted in Russian can be expressed in the English language. At the same time the students consolidate their knowledge on the subject.

The third part of each unit is devoted to listening and speaking activities. At this stage the students are offered to watch some videos and then to discus the problems described in them. For example, studying butterflies as bioindicators they get acquainted with the work of Camille Parmesan who did the research on

how the climate change effects the butterfly populations and who served as a lead author for the Intergovernmental Panel on Climate Change, which in 2007 was awarded the Nobel Peace Prize [NBC Learn 2016; ESI 2011].

Each unit also includes a scientific or popular scientific article given for analysis. This kind of activity teaches the students to search for essential information, develops critical thinking as well as discourse skills, prepares them to the following independent project work. While working on the abstract the students improve their English language skills and simultaneously penetrate into the subject matters analysing phenomena, facts, events and various point of view. This kind of activity is a guided one, conducted under the teacher's supervision.

## 7. Project work

Each unit ends up with project work. Project work advantages have been widely recognized for many years in the teaching practice in relation to what benefits it brings concerning motivation, relevance, and educational values.

The tree types of such activity are practiced. The first type is individual project work involving rendering and annotation of scientific discourse on the topic. Project work thus enables the students to drill the language and professional knowledge that will be of most value to them as language users in their professional environment [OUP ELT 2010]. Furthermore writing a discussion in the framework of the project work encourages the students to assess the current ecological situation; develops attitudes, values and behaviour necessary to conform their lives to sustainable development-related principles.

The second type is the projects that simulate real-life situations, which allow the students to get involved in experiential practices or practical work which is not immediately accessible. These projects give a chance for student-led, collaborative work relative to a real-world problem or issue. In the framework of the course the modeling of the biomonitoring of water quality with macroinvertebrates was done. At the beginning the students got acquainted with the practices of water quality assessment during the English listening and reading activities based on the materials provided by the University of Wisconsin-Extension website [UW-Extension 2012a; 2012b; WAV 2003]. Using the instructions provided by University of Wisconsin, images of macroinvertebrates, the "Key to macroinvertebrate life in the river" and the recording form [UW-Extension 2012c; WAV 2003] they then simulated the same research in the class describing the equipment needed, then how to select the sample sites and the sampling procedure in English. And at the end the presentations in English, in which they showed and

explained the outcomes of the simulated research, were displayed and the ways of solving the problems were discussed.

Simulation activities include not only modeling of field studies but also role plays, debating the results of experiments studied, and gaming giving the students a clear sense of involvement, engaging them with real-world issues, helping them develop appropriate professional behaviours. These activities also provide the students with the opportunity to evaluate the perspectives of living sustainably, to develop the strategies conducive to sustainable development.

The third type is experiential project work which includes participatory activities in real bioindication studies. In this place-based learning, the students work in collaboration with a subject teacher implementing their knowledge in practice.

For example, the air quality assessment using lichens as bioindicators of air pollution was done during the course. It was focused on quantitative evaluation of lichen species in the selected sites which were located nearby the ISEI buildings, Minsk Tractor Works, and Power Station, 3, Minsk. First, the field guide published on the UK Air Pollution Information System website [APIS 2015] and designed by Center for Ecology and Hydrology, Natural History Museum and The University of Nottingham was studied at the language classes. Then, the field study itself was conducted according to the instructions given in the APIS manual in collaboration with the biomonitoring teacher. Finally, the students demonstrated the outcomes of their field work in presentations given in English. During the field work the students showed high engagement and interest which resulted in very informative presentations containing not only the pure results of the study but also the students' discussions, their attitudes, ways of problem solving and knowledge about sustainability issues.

Place-based project work is a particularly useful approach for a CLIL programme as it enables the students to produce a worthwhile product in the language learned and at the same time gives a clear sense of achievement in the professional sphere. Fieldwork and action research are the practices in which learning the principles of sustainable development can be engaged not only with reference to the discipline, but also regarding students' own values and attitudes.

## 8. Conclusion

Considering the benefits of CLIL it is worth to be mentioned that the whole content and language organisation of the course book provides the students with the opportunity to develop high linguistic and professional competence. The dual

aim of CLIL methodology is clearly seen in each kind of activities. The vocabulary section makes the students learn the biomonitoring terminology they have to use in the following tasks. Reading, which is highly important in CLIL classes as the content is paid particular attention to, helps the students revise the material of the lectures and at the same time drills the reading skills and enhances the language learning motivation. Speaking and listening tasks are aimed at both consolidating the knowledge on the subject and the language skills themselves. Text analysis and abstract writing affords the opportunity to obtain additional information on biomonitoring issues and develops skills in academic writing. Project work contributes to the students' ability to demonstrate their comprehension of the subject matters, their skills in composition and discussion and promotes developing of the professional competence. To conclude it should be said that during the experimental course the teachers involved in it noticed students' enhanced advancement not only in biomonitoring but also in learning English. The interdisciplinary process has appeared to be mutually beneficial as the acquisition of knowledge on biomonitoring issues are highly supported throughout the English classes and the language skills are intensively drilled during practical training and project work. Although the developer of the book had no intention to make any comparative analysis, it has become evident through practice that CLIL technologies, rather than ESP, are more suitable, motivating and creative in the light of attaining interdisciplinary goals.

Following the interdisciplinary approach the developer of the course book "English for biological monitoring" has made an effort to embed sustainability in the curriculum. Citing the UNESCO website, Education for Sustainable Development allows every human being to acquire the knowledge, skills, attitudes and values necessary to shape a sustainable future [UNESCO 2014]. The discussion over some key sustainable development issues which are more or less relevant to the topic of each unit is included into the speaking activities and of course they are an integral part of project work as it is believed that students' expertise acquired from different disciplines can be brought to bear on the sustainability problems. There is no doubt that it is just the first step towards the implementing ESD in the CLIL language teaching. The curriculum of the faculty of Environmental Monitoring contains a wide range of disciplines which are planed to be involved in the interdisciplinary educational process. It mainly concerns such disciplines as "Waste Management," "Water Supply and Management," etc. During the CLIL English classes the students, future ecology managers, would have an opportunity not only to acquire the knowledge on the subject they would also study the experience of developed countries in organisation of project work done by students in collaboration with the local enterprises and local communities. In the framework of CLIL classes it is also planned to engage them in place-based project work which relate to there future profession, connect them with their

probable future place of work, and involve them in real-world issues which can help them realise how to make decisions and perform their work in a sustainable manner. This is the field where CLIL technologies and ESD principles can be brought together.

# References

Air Pollution Information System (APIS), 2014, *Monitoring air quality using lichens – field guide and app*, www.apis.ac.uk/nitrogen-lichen-field-manual [access: 29.11.2016].

Boggs C.L., Watt W.B., Ehrlich P.R. (eds), 2003, *Butterflies. Ecology and Evolution Taking Flight*, Chicago: University of Chicago Press.

Coyle D., Hood P., Marsh D., 2010, *CLIL. Content and Language Integrated Learning*, Cambridge: Cambridge University Press, www.langtoninfo.co.uk/web_content/9780521112987_frontmatter.pdf [access: 28.11.2016].

Dudley-Evans T., St John M.J., 1998, *Developments in English for Specific Purposes. A Multi-Disciplinary Approach*, Cambridge: Cambridge University Press.

Education for Sustainable Development (ESD), www.unesco.org/new/en/education/themes/leading-the-international-agenda/education-for-sustainable-development/ [access: 28.11.2016].

Education for sustainable development: Guidance for UK higher education providers (QAA & HEA), 2014, www.qaa.ac.uk/en/Publications/Documents/Education-sustainable-development-Guidance-June-14.pdf [access: 28.11.2016].

ESI, 2011, *Global Warming: Impacts on Wildlife and Society*, www.youtube.com/channel/UCXzicKpfSXa90q54SE6Nx5Q [access: 30.11.2016].

European Communities, 2004, *Promoting Language Learning and Linguistic Diversity. An action plan 2004-06*, Luxembourg: Office for Official Publications of the European Communities, http://europa.eu.int/comm/education/doc/official/keydoc/act-lang/act_lang_en.pdf [access: 28.11.2016].

Eurydice. The information network on education in Europe, 2006, *Content and Language Integrated Learning (CLIL) at School in Europe*, Brussels: Eurydice.

Forum for the Future. Higher Education Partnership for Sustainability (HEPS), 2004, *Learning and Skills for Sustainable Development. Developing a sustainability literate society. Guidance for Higher Education Institutions*, London, www.forumforthefuture.org/sites/default/files/project/downloads/learningandskills.pdf [access: 28.11.2016].

*International CLIL Research Journal*, www.icrj.eu/ [access: 28.11.2016].

NBC Learn, 2016, *Adaptation of butterflies*, www.nbclearn.com/changing-planet/cue-card/52835 [access: 30.11.2016].

OUP ELT, 2010, https://oupeltglobalblog.com [access: 29.11.2016].

The University of Wisconsin-Extension, 2012a, *Biotic Index*, www.youtube.com/watch?v=In1Foq4l43A [access: 30.11.2016].

The University of Wisconsin-Extension, 2012b, *Biotic Index_ Determining Stream Quality Using Stream Insect*, www.youtube.com/watch?v=mdhAD6uil7s [access: 30.11.2016].

The University of Wisconsin-Extension, 2012c, *Key to macroinvertebrate life in the river*, http://watermonitoring.uwex.edu/pdf/level1/riverkey.pdf [access: 30.11.2016].

UNESCO, 2012, *Education for sustainable development. Sourcebook*, France, http://unesdoc.unesco.org/images/0021/002163/216383e.pdf [access: 28.11.2016].

UNESCO, 2014, *What is ESD?*, http://www.unesco.org/new/en/unesco-world-conference-on-esd-2014/resources/what-is-esd/ [access: 28.11.2016].

Water Action Volunteers (WAV), 2003, *Citizen Monitoring Biotic Index*, Madison: University of Wisconsin, www.water-research.net/Waterlibrary/Lake/Bugs.pdf, www.water-research.net/Waterlibrary/Lake/bioticindexchart.pdf [access: 30.11.2016].

WHO, 2016, *WHO Releases Country Estimates on Air Pollution Exposure and Health Impact*, www.who.int/mediacentre/news/releases/2016/air-pollution-estimates/en/ [access: 29.11.2016].

## Nauczanie biomonitoringu
## w języku angielskim

**Streszczenie.** Celem artykułu jest przedstawienie sposobu wdrożenia interdyscyplinarnego podejścia do nauczania języka angielskiego opartego na wybranych aspektach zintegrowanego kształcenia przedmiotowo-językowego (CLIL) poprzez połączenie nauki o środowisku i rozwoju zrównoważonym z nauczaniem języka angielskiego. W artykule opisano podręcznik do nauki języka angielskiego jako języka drugiego (ESL) przeznaczony dla studentów monitorowania środowiskowego, studiujących biomonitoring w ramach kursu CLIL. Należy zaznaczyć, że na końcu każdego tematu studenci prezentują projekt, w którym demonstrują wiedzę merytoryczną i językową, jaką sobie przyswoili. Cel ten jest osiągany bez zwiększania wymiaru czasowego programu nauczania.

**Słowa kluczowe:** ESL, biomonitoring, edukacja dla zrównoważonego rozwoju, CLIL, ESP

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# A Modern Approach
# to Teaching Agri-Food Sciences
# in the Context of Sustainability
# and Climate Change Issues

**Abstract.** In this article we propose an approach to developing interdisciplinary teaching modules (ITeM) for sustainable management in agri-food systems, based on our experiences as academic teachers and researchers involved in agri-food disciplines. Each teaching module consists of a series of lectures either for 1st level (bachelor) or 2nd level (master) students. A model of the course is presented and recommended for teaching programmes in the area of Food Science and Technology, Agricultural Science, Food Engineering, Environmental Engineering, Food and environmental Biotechnology.

**Keywords:** food, agriculture, food quality and safety, climate change, law and regulations

## 1. Introduction

Nowadays academic teaching needs to focus much more attention on environmental issues related to agri-food system sustainability in a changing world. Apart from the basics of chemistry, biochemistry, biology and engineering, students are not sufficiently aware of how the water, soil, energy saving, and "zero waste strategies" for food industries might benefit both the production and distribution costs, so giving an important contribution to the mitigation of climate change.

Many basic processes in industry demand high quantities of water and energy (heating, cooling, particle size reduction, mass transfer, etc.) and apart from be-

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ing the basis for manufacturing are also needed for increasing safety and quality of the products. A tremendous amount of energy (and money) delivered to such processes contributes to the influence on climate changes by human activities. There is increasing interest from all involved stakeholders (e.g. producers, distributors, consumers, policy makers etc.) in the reduction of both economic and environmental costs. To achieve this goal, the understanding of all factors that may have an impact on certain processes is essential.

The revision of production and consumption patterns in the agri-food system needs to start from educational programmes, and both teaching programmes and methods should be revised and devised with this objective. This is work for academic teachers. The higher education system should built new bridges between science and industry. Universities are the most appropriate place to merge knowledge from basic science like biology, microbiology, chemistry, food technology and law to present new approaches to teaching, implied as a balance between consumer expectations, capabilities of producers and distributors and environment protection.

As academic teachers and researchers involved in agri-food sector disciplines, our goal is to propose novel interdisciplinary teaching modules (ITeM) in sustainable management of agri-food systems, consisting and based on aims listed in chapters as follows: Food processing, Food quality, Food safety, Recycling and valorization, Regulations.

The teacher/scientist involved in all the above-mentioned fields should combine their knowledge to build teaching modules (single subjects) where every branch will be led by a different teacher (according to their knowledge) ant implemented by other teachers of the module to edify the highest quality of interdisciplinary teaching. Table 1 resumes the organization of ITeM, which will be explained in detail in the following chapter related to the five modules.

Table 1. Resuming scheme with the main characteristic of the proposed ITeM

| Interdisciplinary course characteristics | | |
|---|---|---|
| Suggested for | Food Science and Technology, Agricultural Science, Food Engineering, Environmental Engineering, Food and environmental Biotechnology | | |
| Implemented disciplines | Food and environmental Microbiology, Food Chemistry, Food and Environmental Biotechnology, Legislation | | |
| Modules | 1– food processing, 2 – food quality, 3 – food safety, 4 – recycling and valorization, 5 – legal regulations | | |
| Academic level | Vocational school/college | Bachelor | Master |
| Teaching methods | Lecturing, exercises, teacher-led team working | Lecturing, exercises, student-led team working, brain storming | Lecturing, exercises, brain storming, problem solving, student reporting |

Source: own elaboration.

## 2. Module 1: Food processing

The agri-food system is characterized by a complex and dynamic interaction that starts with the use of the natural resources (land, water, solar radiation, biological diversity, etc.) and has confluence with the food processing procedures. Food industries are connected to the agriculture system, that supplies vegetal- and animal origin raw materials, and the distribution chain and final consumers, with expectations about quality, safety, costs, but also emerging ones related to hedonistic consumption, health benefits, different dietary attitudes, attention to the environment (e.g. organic food) and other. Thus, food processing procedures are already under great transformation and all steps involved in food production must constantly develop according to the expectations of the market, so as rapid changes in law and regulations that deals with health and safety along with environment protection.

An interdisciplinary teaching approach ought to be designed with food processing, as a key step that receives all the input from external factors and needs to comply with old and new issues, including saving of natural resources, climate change effects on quality and safety of final products, and new regulations at national and international level.

Students who are completing their study programmes should be aware of how basic production processes may impact on the environment (climate, natural resources) but also on the economic aspect of production. During their studies, it should be highlighted that basic processes (e.g. reducing in particle size, heating, cooling) that are water and energy demanding can be conducted in a more environmentally-friendly way.

From incremental innovation the goal for modern food technologies is the rebuilding and redesigning of the technological line to use heat transfer more efficiently. In the proposed teaching module, those issues are highlighted during every process description such as the dependency of conditions surrounding the new design. To do this, the teaching module starts with the description of the most common steps in food process lines highlighting critical points in which energy and water consumption can be oriented in a different way, to comply with the new issues of sustainability, environment protection and emission reduction. Food technologies rely on basic equipment and machinery that is shared by different productions (e.g. washing and sorting, fermenters, autoclaves, ovens, dryers, cooling systems, etc.). The teaching module will schematically report all their principles of working, highlight all parts that can be redesigned. Students will be actively involved in brainstorming and group work sessions to develop possible change and adaptation of the original design to follow scenarios of low energy

and water consumption, use of alternative technologies (e.g. high pressures, microwave etc.) that may increase the efficiency of the process.

## 3. Module 2: Food quality

Currently food production processes are aimed at preserving the maximum output of product quality parameters. Maintenance of the highest quality attributes of food is often linked to minimizing the food processing. Some of the main factors that may negatively affect the product quality are high temperature and light. It should be emphasized that at the same time heat treatment process cannot be completely excluded from processing operations in order to stabilize and ensure the safety of the final product. Currently, processes requiring heat treatment of the product are carried out in minimum time with minimum temperature necessary to comply with food safety. The reformulation of the processes should allow the improvement of the performance of their application looking at both economic gain and environmental protection. The role of the module teacher is not only in showing the needs of each process, but also their implications for the technological line, affecting company finances and environmentalimpact.

Moreover, the climate change effects on some food crops is already forcing food industries to change the processing procedures in order to keep the final product's added compounds value, such as facing major changes in basic constituents. Wine industries are currently facing problems of higher temperatures during grape ripening and wine fermentation, with consequent unwanted higher ethanol content in final products and less stability of secondary compounds related to the wine taste [Mozell & Thach 2014: 81-89]. Level of vitamins, antioxidants etc. might be influenced by the increase of the seasonal variation of temperatures, rainfall regime, emerging new plant and animal pathogens in previously safe climate zones etc. thus forcing food industries to counterbalance this variability [Mattheis & Fellman 1999: 227-232; Stanley & Kays 1999: 233-247; Seung & Kader 2000: 207-220; Altunkaya & Gokmen 2008: 1173-1179]. In the food quality module, after the presentation of some case-studies in that field, student will be actively involved in the discussion of possible new strategies for increasing or maintaining the quality level of food products, by facing the new issues of sustainability and climate changing.

## 4. Module 3: Food safety

At present, microbiological safety of food is mainly based on the use of high temperature treatment or sanitizers (like chloride in the washing steps of raw materi-

als), that are effective against pathogenic microorganisms. Other treatments are often coupled to temperature treatment to increase both the safety and the shelf life, like the use of salt, nitrates, sulfites, and other preservatives with bacteriostatic effect. The time-temperature level treatments are determined on the basis of the product characteristics (e.g. physical status, thermal stability of sensory and functional compounds, form, type and size of packaging etc.). From a water and energy saving perspective, food technologies can be consistently revised in order to increase the efficacy of the "killing steps" treatment coupling to reduction in water, chemicals and thermal energy use. The ITeM will be focused on the description of case studies in which food industries improved the treatment effectiveness together with consistent reduction of water use and time-temperature treatments. Moreover, a detailed description of how the faster and more reliable diagnostic methods for detecting biological and chemical hazards in food, starting from the raw materials, can consistently reduce the need of high energy and water consuming treatments, by increasing prevention of contamination episodes in the food chain.

Climate change may have both direct and indirect impact on the occurrence of food safety hazards at various stages of the food chain. Emerging hazards in primary production could influence the design of the safety management systems required to effectively control those hazards and ensure the safety of the final product. Furthermore, increasing average temperatures such as increased frequency of heavy precipitation events and extended dry periods could increase hygiene risks associated with storage and distribution of food commodities [FAO 2008].

Food producers are already facing challenges in food safety and risk assessment, like increased incidence of algal toxin in fish products, mycotoxins in food crops, an increased spread of emerging pathogens (e.g. *Vibrio vulnificus*, *Campylobacter* spp.), increased content heavy metals and micropolluttants in food matrices [Tirado et al. 2010: 1745-1765]. By consequence, law and regulations will introduce food safety requirements that will need rapid adaptation of regulatory and voluntary food safety management plans by industries.

The aim of the ITeM in this section is to focus the lectures and exercises in a blended course with chemistry and microbiology teachers, in which all the possible aspects of increased safety hazards will be evaluated and possible remediation strategies will be discussed with the students, by a problem solving approach.

One of the methods to prevent occurrences of threats is the widespread introduction of HACCP (Hazard Analysis and Critical Control Points). This system aims at minimizing the hazard through a well-developed system of supervision and control. However, for the system to work effectively it is necessary to make an in-depth analysis of all production processes. Benefits of the HACCP system are related not only to the safety of the product but environmental protection as well.

Records relating to the application of HACCP are contained not only in the legal regulations (EU) but also in Codex Alimentarius [Regulation No 852/2004, FAO Codex Alimentarius Standards].

Due to the emerging science, alternative ways to ensure the safety (and quality) should also be explained. The practice part of implementing Food Safety into the teaching module can rely on groups (2-4 student) working on the possible implementation of HACCP to the chosen part of technological lines of food production.

# 5. Module 4: Recycle and valorization

The food industry produces large fractions of the total amount of hazardous waste for the environment [Parfitt, Barthel & Macnaughton 2010: 3065-3081]. This is related to the high energy content of these products and their abundance in nutrients. Improper management of these wastes may result in serious consequences for the environment. Concerns are related to the possibility of pollution of water reservoirs and soil. The existing technologies (wastewater aerobic biological treatments, to anaerobic digestion of liquid and solid wastes, composting) often requires high amounts of energy that can be consistently saved with innovative processes. As an example, the oxygen demanding removal of excess ammonia-nitrogen from liquid and solid waste can now be achieved by novel microbiological processes at low oxygen level, like the "Anammox" process [van Dongen, Jetten & van Loosdrecht 2001: 153-160]. Moreover, strategies of Co-digestion of livestock manure and food waste in an integrated system [Banks, Salter, Heaven & Riley 2011: 71-79] could be a common solution to transform part of the residues of agri-food sector into biogas, with a potential recovery of the energy content of the organic waste, together with the reduction in greenhouse gas emission. The ITeM will present several case studies and then develop with the students a design of food processing that includes waste valorization and recycling (from the plant cultivar, to the packaging and logistic) as an essential part of the product and the process itself.

# 6. Module 5: Legal regulations

Cardinal points of each production are the regulations, which shape the nature, quality and product safety. Legal regulations on food in the EU countries are the basis for detailed regulations of each country. Regulations govern, among other

things, the labeling of a food product, content of selected ingredients, food additives, aromas, enzymes, mineral components, determining food safety, and traditional specialty foods [Regulation (EC) No: 1924/2006, 178/2002, 852/2004, 509/2006, 510/2006, 1925/2006, 1332/2008, 1333/2008, 1334/2008]. These provisions, in addition to regulating issues based on generally understood principles of human and animal life, and the environment, ensure the fair exchange of goods protection.

Another key item is the voluntary labelling. Voluntary characters of application should be emphasized but not in the arbitrariness of their use. An entity choosing to implement them should follow in accordance with the appropriate provisions. An example of such regulations are "good practices" GMP (Good Manufacturing Practice), GHP (Good Hygiene Practice), GVP (Good Veterinary Practice), GTP (Good Trade Practice), GDP (Good Distribution Practice), GAP (Good Agricultural Practice), GLP (Good Laboratory Practice) [EudraLex 2015]. (Not all of them are voluntary regulations, some of them enter into enforced legislation.) Consumer's increasing awareness should influence on better understanding of labeling information with respect for products manufactured in accordance with certain principles (e.g. ecologically, traditionally, in the protection of the environment, animals, natural resources). In order to receive such a certificate (and therefore the labeling of the product) on analysis of the production processes should be carried out by an independent team of experts. Unfortunately, many certificates/characters are used freely and often the only requirement for labeling is a fee for the certifying company.

Another problem that should be considered during the teaching program is a need for the detailed verification of certificates/marks on packages, which are often confused with other signs, and done so intentionally. An example of such confusing marks can be CE *(Conformité Européenne)* and CE (China Export), in which the last one does not give us any information (Figures 1, 2).
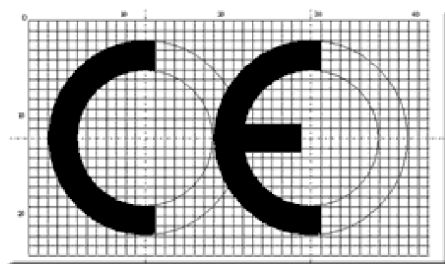


Figure 1. CE mark

Source: https://ec.europa.eu/growth/single--market/ce-marking_en [access: 14.12.2016].



Figure 2. China Export mark

Source: www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+WQ+P-2007-5938+0+DOC +XML+V0//EN [access:14.12.2016].

The benefits of presenting to students law regulations related to the production of food will contribute to increased awareness, better understanding of the complexity and the need for continuous training/track changes in the field of food law.

# 7. Implementation in educational programs

The ITeM in sustainable management of agri-food systems is intended as an integrative and intensive course that can be implemented in official teaching programs. In the case of bachelor degree level, it is suggested after the 3rd semester, when the students from the suggested courses are supposed to have already acquired proficiency in basic mathematics and physics, chemistry and biology. The purpose is to introduce sustainable management in all aspects of each subject by linking them in an interdisciplinary perspective. By a major use of lecturing, students will be introduced to the topics with examples and case studies, followed by student-centered teaching by means of work groups and problem solving exercises. For Master degree level, the ITeM will focus more on advanced processes and design, involving the students in the development of new processes for quality, safety and recycling, such as new regulations that fulfill the goal of sustainability and comply with climate change issues. Official teaching programs could benefit from an additional outcome for the students attending the ITeM, since they will increase their knowledge about how innovation and revenue increase in the agri-food sector revenue is consistent and not incompatible to sustainability. Paradigmatic is the need for adaptation and mitigation strategies that have to be put together to protect agriculture and food production from the negative effects of climate change.

The second step of our proposal is the ex-novo development of bachelor and master courses, such as intensive courses designed following the ITeM principles and application.

# 8. Conclusions

By combining several fields of study in one learning module our ITeM would provide an interdisciplinary knowledge to students that will be finalized towards combining the potential greater financial return for the company and protection of natural resources. So far, the containing and the adaptation to climate

change, along with introduction of sustainability criteria in the agri-food system has always been considered as an additional obstacle, or an extra cost, for the food chain production and distribution. Our goal is to change the perspective into profitable innovation, in which energy and water saving processes, integration of reuse and valorization strategies, adaptive changes in processing lines, can increase the resilience of the agri-food system, together with economic benefits. The cross sectorial and cross scale level of knowledge of future tdxechnologists, engineers, nutritionists and agronomists, is a key challenge to design a better future for the agri-food system in a complex and dynamic changing world.

# References

Altunkaya A., Gokmen V., 2008, Effect of various inhibitors on enzymatic browning, antioxidant activity and total phenol content of fresh lettuce (Lactuca sativa), *Food Chemistry*, 107, 1173-1179.

Banks C.J., Salter A.M., Heaven S., Riley K., 2011, Energetic and environmental benefits and economic feasibility of co-digestion of food waste and cattle slurry: A preliminary assessment. *Resources Conservation and Recycling*, 56, 71-79.

Codex Alimentarius International Food Standards, www.fao.org/fao-who-codexalimentarius/standards/list-of-standards/en/ [access: 15.12.2016].

Dongen U. van, Jetten M., Loosdrecht M. van, 2001, The SHARON Anammox process for treatment of ammonium rich wastewater, *Water Science and Technology*, 44(1), 153-160.

EudraLex – EU Legislation: EudraBook V1 EudraLex Good Manufacturing Practice (GMP) guidelines, Vol. 4, May 2015 / EudraLex V30, January 2015, http://ec.europa.eu/health/documents/eudralex/vol-4_en [access: 15.12.2016].

Food And Agriculture Organization of the United Nations (FAO), 2008, *Climate change: Implications for food safety*, Rome.

https://ec.europa.eu/growth/single-market/ce-marking_en [access: 15.12.2016].

Mattheis J., Fellman J., 1999, Pre-harvest factors influencing flavor of fresh fruit and vegetables, *Postharvest Biology and Technology*, 15, 227-232.

Mozell M.R., Thach L., 2014, The impact of climate change on the global wine industry: Challenges and solutions, *Wine Economics and Policy*, 3(2), 81-89.

Parfitt J., Barthel M., Macnaughton S., 2010, Food waste within food supply chains: Quantification and potential for change to 2050, *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365, 3065-3081.

Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32002R0178&from=PL [access: 15.12.2016].

Regulation (EC) No 509/2006 of 20 March 2006 on agricultural products and food-stuffs as traditional specialties guaranteed, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006R0509&from=EN [access: 15.12.2016].

Regulation (EC) No 510/2006 of 20 March 2006 on the protection of geographical indications and designations of origin for agricultural products and foodstuffs, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006R0510&from=en [access: 15.12.2016].

Regulation (EC) No 852/2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs, http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32004R0852&qid=1481289259631&from=PL [access: 15.12.2016].

Regulation (EC) No 1332/2008 of the European Parliament and of the Council of 16 December 2008 on food enzymes and amending Council Directive 83/417/EEC, Council Regulation (EC) No 1493/1999, Directive 2000/13/EC, Council Directive 2001/112/EC and Regulation (EC) No 258/97 (Text with EEA relevance), http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:354:0007:0015:en:PDF [access: 15.12.2016].

Regulation (EC) No 1333/2008 of the European Parliament and of the Council of 16 December 2008 establishing a common authorization procedure for food additives, food enzymes and food flavorings (Text with EEA relevance), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008R1333&from=it [access: 15.12.2016].

Regulation (EC) No 1334/2008 the European Parliament and of the Council of 16 December 2008 on flavorings and certain food ingredients with flavoring properties for use in and on foods and amending Council Regulation (EEC) No 1601/91, Regulations (EC) No 2232/96 and (EC) No 110/2008 and Directive 2000/13/EC (Text with EEA relevance), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008R1334&qid=1485170970175&from=EN [access: 15.12.2016].

Regulation (EC) No 1924/2006 of the European Parliament and of the Council of 20 December 2006 on nutrition and health claims made on foods, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006R1924&qid=1485171037927&from=EN [access: 15.12.2016].

Regulation (EC) No 1925/2006 of the European Parliament and of the Council of 20 December 2006 on the addition of vitamins and minerals and of certain other substances to foods, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006R1925&from=PL [access: 15.12.2016].

Seung K., Kader A., 2000, Pre-harvest and postharvest factors influencing vitamin C content of horticultural crops, *Postharvest Biology and Technology*, 20, 207-220.

Stanley J., Kays S., 1999, Pre-harvest factors affecting appearance, *Postharvest Biology and Technology*, 15, 233-247.

Tirado R., Clarke, L.A., Jaykus A., McQuatters-Gollop J., Frank M., 2010, Climate change and food safety: A review, *Food Research International*, 43, 1745-1765.

www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+WQ+P-2007-5938+0+DOC+XML+V0//EN [access: 15.12.2016].

# Innowacje w programie nauczania w dziedzinach rolno-żywnościowych w aspekcie zmian klimatycznych

**Streszczenie.** Na podstawie doświadczenia autorów jako nauczycieli akademickich i naukowców w artykule zaproponowano interdyscyplinarny model tworzenia modułów dydaktycznych (ITeM) w zrównoważonym zarządzaniu w dziedzinach rolno-żywnościowych. Każdy moduł składa się z serii wykładów przeznaczonych dla studentów z I (licencjat) lub II poziomu (magister). Przedstawiony model może być stosowany w programach nauczania w zakresie: nauki i technologii żywności, nauk rolniczych, inżynierii żywności, inżynierii środowiska i biotechnologii środowiska.

**Słowa kluczowe**: żywność, rolnictwo, jakość i bezpieczeństwo żywności, zmiany klimatu, regulacje prawne

Oleksandra Khalaim*

# Climate Change Games
# as an Effective Tool for ESD Practices

**Abstract.** Climate change is one of the most acute problems humanity is facing nowadays. At the same time, the school curriculum in Ukraine in most cases does not include up-to-date, practically oriented knowledge about climate change threats. For this reason this study describes examples of well-known climate change games, translated and adapted for use in Ukrainian schools and aims to analyze role playing games about climate change as a tool that can be used in Education for Sustainable Development (ESD). The article describes 12 games selected from 5 open-access sources (like WWF, Red Cross Climate Centre), which were used in pilot studies conducted in 5 Ukrainian schools in order to estimate their applicability in the school educational program for biological disciplines. The results indicate a significant effect of raising the level of understanding of climate change threats and solutions; the proposed games can efficiently cover the educational gap in this field.

**Keywords:** climate change education, ecological games, ESD, role playing games

## 1. Introduction

Evidentially, climate is changing nowadays. Weather observations both in Ukraine and abroad demonstrate the tendency to a warmer Earth: significant temperature increase and reduced precipitation in summer months are expected in the upcoming century, which will lead to more frequent hot and dry patterns [Jylha et al. 2008: 441-462; Shevchenko et al. 2014: 5-7; Gorny et al. 2016: 176-191]. The National Aeronautics and Space Agency (NASA) has reported that the

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six-month period from January to June 2016 was the planet's warmest half-year on record, with an average temperature 1.3º C warmer than the late XIX century.[1]

Among the instruments of adaptation and mitigation the climate change consequences, education for sustainable development (ESD) plays an essential role. The United National Framework Convention on Climate Change (UNFCCC) has "a sharp and sustained focus on education, training, and public awareness" according to its Article 6. Under the UNESCO Climate Change Initiative, which was launched at the 15th Conference of the Parties to the UNFCCC (COP15) in 2009, the Climate Change Education for Sustainable Development Programme has been formed. The Programme foresees making climate change education a more central and visible part of the international response to climate change by helping young people to understand the impact of global warming today and increase their "climate literacy." Among others, it emphasizes the necessity of encouraging innovative teaching approaches to integrate climate change education in schools and raising awareness about climate issues within non-formal education programs [UNESCO Climate Change Initiative 2010: 3-5]. The critical role of education in climate change was emphasized at the two last COP events: the Paris Climate Conference (COP21) in December 2015 and COP22 in Marrakech, 2016 [UNESCO Climate Change Education 2016: 1-4].

Despite the more visible presence of ESD concept the in Ukrainian education nowadays, the school education programs here mostly do not provide any up-to-date, practically oriented knowledge about the climate change threats in a system manner. The ESD methodology together with some aspects of climate change education is being implemented in particular study courses in universities, like "Climate Change and ESD for Engineers" [Soloshych & Pidlisnyuk 2009: 229-232] or "Energy Efficiency in ESD" [Zahvoyska 2011: 295-303]. EDS methodology has been adopted for school education also [Pometun 2015: 1-120]. Such implications have a non-systemic character without enough use of interactive methods and renewed materials due to a weak methodological and material base, lack of translated or adapted courses and supporting information related to climate change issues.

It should be taken into account, that climate literacy foresees an understanding of both climatic processes and social responses in order to realize some positive changes for a sustainable environment with the help of competencies of inquiry-based and problem-based learning [Makrakis, Larios & Kaliantzi 2013: 54-72]. The climate change Education for Sustainable Development is a necessary part of the increasing the climate literacy using innovative teaching methods. Among them, ecological games should be mentioned as an interactive educa-

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[1] www.nasa.gov/feature/goddard/2016/climate-trends-continue-to-break-records [access: 18.01.2017].

tional tool which allows involving participants in a more active manner in seeking the practical solutions instead of a passive obtaining the "dry theory" on the problems posed [Wu & Lee 2015: 413-418].

This study represents a case of climate change games translation and adaptation for use in Ukrainian schools and aims to analyze the climate change role games as a tool of the climate change Education for Sustainable Development.

## 2. Materials and methods

In this study, we have estimated the possibility to implement in Ukrainian formal education a number of games and exercises on climate change and adaptation issues based on materials of international non-governmental organizations dealing with ecological education. These activities have been performed within the social ecological project "While Playing, Change the World" (March-August 2016) supported by Climate Forum East II Program of European Union, Austrian Development Cooperation, and Red Cross. The project aimed improving the capacity of teachers in teaching the topics of climate change and related subjects such as geography, biology, ecology and environmental protection; strengthening the capacity of NGOs to work with schools in their regions; and increasing awareness of climate change and adaptation in schools as well as among young activists of regional NGOs. The main project activities have included: (1) compiling, adaptation, translation into Ukrainian, and distribution the handbook "While Playing, Change the World: A Climate Games Handbook" [Khalaim 2016: 1-44] with a set of games and interactive methods on climate change; and (2) conducting a 2-days all-Ukrainian Forum "Climate Education – 2016" for organizations working in this field, active educators, and other stakeholders with trainings on the games from the handbook.

For the handbook we have chosen 12 free-access "real-time" games which fit the following criteria:

– short duration (15-40 min.) – to an easy inclusion of the games into regular school lessons of a 45 min. duration,

– easy rules – to reduce the time needed for teacher's preparation and pupils' understanding,

– any complicated handouts are necessary (black-and-white printing at an office paper only in some cases) – to make the games affordable for teachers from any village school with a poor material base,

– devoted to the climate change issues, including basic facts and general functioning, individual input, possible adaptation and mitigation activities, etc.

The games have been taken from five free informational web sources:

– ATACC "Handbook for action against climate change", International Falcon Movement-Socialist Educational International [Sudbrock & Pearce 2012],[2]

– Climate Box: an interactive learning toolkit on climate. Developed for 2-11 school grades by UNDP, Moscow [Berdin, Gracheva & Dobrolyubova 2015],[3]

– Educational Games. Red Cross Climate Centre with the IFRC's Department of Community Preparedness and Risk Reduction,[4]

– Communicating Adaptation Role Playing Exercise. © World Wildlife Fund, Inc. [Shaun 2013],[5]

– Participatory Exercises for Adaptation Training. World Wildlife Fund Adapt Learning Resource (2015).[6]

All games have been adapted to Ukrainian auditory by providing specific examples and local cases. Aiming to check its compatibility with the current school curriculum for biological disciplines and to estimate its applicability to pupils' demands, we have conducted the chosen games in 5 pilot Ukrainian schools in Dnepropetrovksa, Cherkaska regions and Kyiv in May-June 2016 with the help of local teachers (Shvedun Hanna, Sankivska Iryna, and Valantyrets Natalia). The teachers have provided feedback after working with these games, having pointed out:

– age and number of participants,

– how have games been perceived by the participants (indicating likes or dislikes; level of games' understandability; level of participants' engagement),

– how much time did it take to play each game,

– recommendations for the games' further improvement.

We have collected all feedbacks and have made a generalization on its basis, pointing out the most relevant outcomes.

## 3. Results

The Climate Change Games conducted in five pilot schools has been well perceived by the participants, raising the level of their understanding of the climate change threats and solutions. The local trainers have concluded that the proposed games can efficiently cover the educational gap in this field.

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[2] www.ifm-sei.org/files/up/ATACC-publication-web.pdf [access: 18.01.2017].

[3] www.undp.ru/documents/ClimateBoxEng/Climate-box-ENGLISH_an_illustrated_textbook.pdf [access: 18.01.2017].

[4] www.climatecentre.org/resources-and-games/games [access: 18.01.2017].

[5] http://wwfadapt.org/participatory-exercises/Communicating_Adaptation.pdf [access: 18.01.2017].

[6] http://wwfadapt.org/participatory-exercises.html [access: 18.01.2017].

The games have been conducted for a quite wide age range of pupils: from 8 years old (2nd grade) through 13 years old (7th grade) to 17 years old (11th grade and evening school attendees), with 12-25 participants per group. The participants liked the proposed games mostly; more interactive, ice-breaking games were perceived better, encouraging pupils to catch the ideas behind with some accompanying activities. Thus, the game "Answer with Your Feet"[7] allows participants and facilitators learn about characteristics and composition of the group and a little about one another in a dynamic way by splitting the group in space according to their answers to the climatic questions. It helps to show the influence of climate change consequences on the majority of people in a usual life, especially when it cannot be visible without a generalization. For example, splitting the group according to answers "yes/no" to the question "Did you noticed the snow in Carpathian mountains last winter?" helps participants to observe, what kind of climate-related observations and influences they can experience similarly.

We have selected nine games with feedback from the local trainers and put them in Table 1. The short games' description and information of the participants' age and amount allows observing the reasons behind comments and proposals on the games' improvement.

According to the comments and results of game practice, the games of ATACC Handbook for action against climate change [Sudbrock & Pearce 2012] has been perceived well by the participants and were easy-to-use for trainers. At the same time, a low level of understanding of climatic processes which lie behind the climate change and greenhouse effect by school children in regional Ukrainian schools [Pometun 2015: 1-120] should be taken into account in the work on games' adaptation to Ukrainian educational process. Introducing such games as Communicating Adaptation Role Playing Exercise, some fundamental knowledge about the mechanisms of climate change should be provided. The exercise foresees practicing the communication skills by trying to persuade a partner to do something that is helpful for climate change adaptation or stop a potentially maladaptive activity, using a prepared scenario and roles [Shaun 2013: 1-3].

The games based on the ecological footprint calculations help participants to estimate their consumption patterns critically and to compare it with best practices. The participants should answer a list of questions related to their lifestyle preferences, thus determining the level of energy and materials consumption to compare it to others and to the Earth's carrying capacity. The proposed questionnaire has raised some comments by participants indicating the necessity to be adapted to Ukrainian traditional way of consumption and living [Khalaim 2016: 1-44]. For example, the questions about carpooling or following the vegan diet are not so relevant for an average Ukrainian school-aged child and should be re-

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[7] www.climatecentre.org/resources-games/answer-with-your-feet [access: 18.01.2017].

Table 1. Selected Climate Change Games and their approbation in five Ukrainian schools (May-June 2016)

| Nr | Game title and brief description | Participants: age / school grade / amount | Duration (min.) | Feedback / comments / recommendations |
|----|----------------------------------|-------------------------------------------|-----------------|----------------------------------------|
| 1 | Impact Game2<br>Everyone stands in a circle; each person chooses another person to copy. When you say go, everyone has to try to hold as still as possible, but people will inevitably make small movements. Each participant should copy their chosen person's movements, but exaggerate them just slightly. The game ends when everyone is jumping in the air or rolling on the floor!<br>This energizer shows how small changes can have a large impact. | 12 / 6th grade / 22<br>13 / 7th grade / 12<br>13-14 / 7th grade / 19<br>14-15 / 8th grade / 23<br>15-16 / 10th grade / 18<br>16-17 / 11th grade / 15 | 10-15 | A room size should be enough for active movements.<br>A trainer should be actively engaged in the process.<br>In the case of open-air playing conditions, the involvement of the participants is more active.<br>Under the school educational process, it is impossible to finish the game when "everyone is jumping in the air or rolling on the floor" – chaotic movements could be enough for the demonstration of the "butterfly effect." |
| 2 | Globingo2<br>Sit in a circle. One person doesn't have a chair and stands in the middle. The person in the middle says an activity that contributes to climate change. All participants who answer this with yes need to change places. The person in the middle tries to get a chair. Examples: Change places if…<br>You like eating food from other countries; You have ever been abroad by plane; You eat meat;<br>You don't recycle everything you can; You … | 8 / 2nd grade / 20<br>13 / 7th grade / 16<br>14-15 / 8th grade / 24<br>15-16 / 10th grade / 21 | 10-15<br>or<br>30-35 | In the case of the limited space (classroom) participants can walk freely between chairs and sit down if they answer "yes"; others keep walking.<br>In the case of open-air playing, chairs are not necessary to use (participants can change marked circles on the asphalt/ground).<br>It is necessary to discuss which processes/actions influence climate change and how. |
| 3 | Energy Game2<br>Explain that there are different types of fuel we use to get energy. Some of these are called 'fossil fuels' (coal, oil, and gas). They are dirty to use, and the gases they give off are making the earth warmer. There are sources of energy that do not have a bad effect on the environment (power from the wind, waves, the sun and rivers). Call out different words, and the group, | 8 / 2nd grade / 20<br>13 / 7th grade / 16<br>15-16 / 10th grade / 21 | 10-15 | Participants sat on their chairs in the case of 'fossil fuels.'<br>The game is quite simple and easy-to-use; it could be effective for pupils from 2nd to 6th grades.<br>The game is a good energizer in the case of open-air playing; could be used in eco-camps. |

| | | | | |
|---|---|---|---|---|
| | should respond with various actions, as follows: the wind (run around the room blowing), waves (swim around the room), sun (stand still with eyes closed), and rivers (spin arms around each other in front like a turbine). Occasionally shout 'fossil fuels.' At this everyone should sit down in a ball (like a piece of coal) and shout back 'no thank you.' | | | |
| 4 | The World in 2050² Tell participants that they will take a trip into the future in their minds. The destination is the year 2050. Ask everyone how old they will be then and what they want to do at that age. What will your town look like? How will people move around? How will you and other people live? What will your homes look like? What will the countryside look like in 2050? What will have changed from now? Tell participants that they will create a newspaper for 2050, using their imagination. In pairs, they should create one or two newspaper items. They can be interviews, point of view columns, news stories, cartoons…all with catchy headlines. Put all news items on a big 'wall-newspaper' displayed on a wall, and give time for everyone to read everything. Later on, you can also lay them out in a regular newspaper format. | 8 / 2ⁿᵈ grade / 20 13-14 / 7ᵗʰ grade / 17 14-15 / 8ᵗʰ grade / 24 15-16 / 10ᵗʰ grade / 23 | 20 or 70-90 | The game could be accompanied with additional information/presentation with the main climate change consequences and prognosis. The game requires more time than it was supposed to; according to the age of participants, it took 70-90 minutes in overall (faster for elder pupils). For more effective playing, a preparatory reading should be asked; The proposed prognosis on 2050 is too pessimistic and should be replaced by more optimistic one, like "In 2050 the new vaccine against AIDS is developed". The game has encouraged and called a high interest among teenagers, who used a creative and sometimes humoristic approach to news' writing. |
| 5 | How Bad are Bananas? 2 In this activity participants discuss the impact of different actions on their carbon footprint. Impact cards are used; all figures are taken from the book 'How Bad are | 12 / 6ᵗʰ grade / 22 13 / 7ᵗʰ grade / 12 13 / 7ᵗʰ grade / 18 15-16 / 10ᵗʰ grade / 25 | 20-25 or 70 | The number of cards sometimes is bigger than the number of participants; some cards cannot be discussed then. We propose trainer to read/present all cards for participants in advance. |

Table 1 – cont.

| # | | Age / grade / number | Time | |
|---|---|---|---|---|
| | Bananas?' (Berners-Lee, 2010). The numbers are estimates of Carbon Dioxide 'equivalents' (CO2e), also taking into account other greenhouse gases. Ask everyone in the big group to form a line, with high impact carbon items at one end of the room, and lower impact activities on the other end of the room. They should discuss with each other while trying to form an order. When they have decided on a line, ask everyone to say what they are. Then they can put their card on the floor in the same order. Participants can add the numbers to the cards. Ask participants to choose the activities that they can't have any individual influence on, but that need to be carried out by a higher level (city administration, national politics...) and put them in a separate line. | | | The game is quite impressive concerning the demonstration of the ecological consequences of the small actions/decisions. The card "Having a child in Europe (373 tones CO2e on average)" is not understandable for Ukrainian pupils and should be replaced. The group size should be limited to 5-15 participants to avoid loudness during discussions. Cards (actions, items, and their carbon footprint) should be discussed in advance to shorten the necessary time for joint discussions. |
| 6 | Answer with your feet An ice breaker for medium to large groups unfamiliar to each other; or a quick and more engaging way to answer specific questions. Participants are asked to stand in an open space. This is a physical game where people arrange themselves across the room according to different criteria that will be called out by the facilitator. The facilitator must call up a subject and the appropriate organizational strategy that the participants must adopt to distribute themselves across the room. | 13 / 7th grade / 12<br>13 / 7th grade / 16<br>13-14 / 7th grade / 19<br>14-15 / 8th grade / 17 | 10-15 | For the participants' redistribution in the room space, we used a rope which separated some parts of the floor for different groups. Participants liked the game very much. The climatic questions should be put into the game; we used the questions from "Globingo". A number of participants should be limited to 5-15 persons. |
| 7 | Icebreaker: How has climate change affected your life?[6] Give to participants a few minutes to think of a response to the following question: "How has climate change or extreme weather affected your life or the lives of people you know? You may draw upon experiences in | 13-14 / 7th grade / 19<br>14-15 / 8th grade / 23<br>15-16 / 10th grade / 18<br>17-18 / evening school / 14 | 20-25 or 45 (one school lesson) | For pupils from one group who know each other well the game could be used after summer vacation or any other big time period without meeting each other frequently. |

| No. | Activity | Age / grade | Time | Notes |
|---|---|---|---|---|
|  | either your personal or professional lives or both." After a few minutes have passed, ask participants to introduce themselves to others at their respective tables and briefly tell their colleagues the answer to the above question. Allow about 15-20 minutes for this to happen. Stop the discussion and ask each table to select one response to tell all participants in the workshop. Participants may tell their stories or tell a story of one of their colleagues at their table. Give each table about 1-2 minutes. The game developed by Eliot Levine, WWF |  |  | The game foresees that all participants know well the main consequences and evidence of climate change; if they are not well-prepared, first questions should be simpler, f.i.: "What kind of abnormal/extreme weather events have you observed in your town recently?" |
| 9 | Understanding Your Climate We often discuss climate change as if we already thoroughly understand the historic climate, its role in local ecology, culture, and economies. It is difficult to see change if we do not understand where we are starting from. Through this participatory exercise, participants will use their current knowledge to jointly develop a visualization of the historical annual climatic cycle for their region of interest (usually where they live or work). This activity also helps facilitators and trainers to understand better the climate of a region that they may be unfamiliar with. This will be helpful in facilitating subsequent discussions about local climate change. For more details see the source5. The game developed by Shaun Martin, © World Wildlife Fund, Inc. 2013 | 15-16 / 10th grade / 21 16-17 / 11th grade / 22 17-18 / evening school / 15 | 20-25 or 45 (for 11th grade) and 60 (for 10th grade) | Tape was not used, we wrote our observations on the blackboard with colored chalk. The game is more efficient for elder pupils; in the case of middle school makes sense to discuss general ecological problems of each month after the creation of the climatic calendar. Finally, a schedule of eco-friendly activities could be created on the base of previous data written on the board. |

[119]

Source: own elaboration.

placed with more familiar tasks (like frequency of meat consumption for their family and public transport use).

In general, the comments and recommendations provided to the games have highlighted the necessity to ensure the process of games' adaptation to the national educational and sociological context. Even in the case of high-quality game materials developed by experienced and practically oriented organizations like WWF and Red Cross, misunderstanding can occur for participants on game tasks or questions. It can be explained by the difference in Eastern and Western socio-cultural and living background and educational values, which historically influenced the lesson tasks' formulation within the school study process.

# 4. Conclusions

The introduction of climate games in the educational process in Ukraine can cover the need in the practical knowledge, linking global processes with the local consequences and providing suggestions how to deal with / adapt to / solve the problem of climate change for the school youth.

Climate change games effectively ensure a practical involvement of participants in a "simulated" decision-making process, linking causes and consequences. "Learning by doing" approach has approved its effectiveness during the pilot games conducting.

Implementing of ecological games to the teaching process can improve the capacity of teachers on the topics of climate change and related subjects such as geography, biology, ecology, and environmental protection in an innovative and interactive way. This universal and technically accessible educational tool contributes effectively to raising awareness of climate change and adaptation in schools as well as among volunteers, activists of regional NGOs, and youth.

At the same time, a basic knowledge of climatic processes, greenhouse effect, mechanisms, and scenarios should be provided at the beginning of game activities. The necessity to adapt foreign materials to Ukrainian socio-cultural context, as well as to the post-Soviet educational school system, should be taken into account.

# 5. Acknowledgements

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# References

Berdin V., Gracheva E., Dobrolyubova Y., 2015, *Climate Box: An interactive learning toolkit on climate change*, Moscow: United Nations Development Programme.

Gorniy V., Lyalko V., Kritsuk S., Latypov I., Tronin A., Filippovich V., Stakevych S., Brovkina O., Kiselyov A., Davida T., Lubskiy N., Krylova A., 2016, Forecast of thermal response of urban environments of Saint-Petersburgh and Kyiv to climate change (based on EOS and Landsat satellite imagery), *Current problems of remote sensing of the Earth from space*, 13(2), 176-191.

http://wwfadapt.org/participatory-exercises/Communicating_Adaptation.pdf [access: 18.01.2017].

http://wwfadapt.org/participatory-exercises.html [access: 18.01.2017].

Jylha K., Fronzek S., Tuomenvirt H., Carter R., Ruosteenoja K., 2008, Changes in frost, snow and Baltic sea ice by the end of the 21 century based on climate model projections for Europe, *Climatic Change*, 86, 441-462.

Khalaim O. (ed.), 2016, *While Playing, Change the World: A Climate Games Handbook*, Kyiv: CFE.

Makrakis V., Larios N., Kaliantzi G., 2013, ICT-Enabled Climate Change Education for Sustainable Development Across the School Curriculum, *Journal of Teacher Education for Sustainability*, 14(2), 54-72.

Pometun O. (ed.), 2015, *Preparing teachers to teach sustainable development issues*, Kyiv: Naukova Dumka.

Shaun M., 2013, *Communicating Adaptation Role Playing Exercise*, World Wildlife Fund, Inc., http://wwfadapt.org/participatory-exercises/Communicating_Adaptation.pdf [access: 18.01.2017].

Shevchenko O., Vlasyuk O., Stavchuk I., Vakolyuk M., Ilyash O., Rozhkova A., 2014, *Evaluation of vulnerability to climate change: Ukraine*, Climate Forum East, Working Group of Civil Organizations on Climate Change.

Soloshych I., Pidlisnyuk V., 2009, Innovative approaches in education for the formation of professional ecological competences of future specialists as the component for sustainable development, *Visnyk KDPU M. Ostrogradskogo*, 6(59), 229-232.

Sudbrock C., Pearce T. (ed.), 2012, *ATACC Handbook for action against climate change. International Falcon Movement-Socialist Educational International,* IFM-SEI.

The United National Framework Convention on Climate Change, 1992, http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf#page=17 [access: 18.01.2017].

UNESCO Climate Change Education and COP22, 2016, http://unesdoc.unesco.org/
    images/0024/002464/246479E.pdf [access: 18.01.2017].

UNESCO Climate Change Initiative: Climate Change Education for Sustainable De-
    velopment, 2010, Paris, France, http://unesdoc.unesco.org/images/0019/0019
    01/190101E.pdf [access: 18.01.2017].

Wu J., Lee J., 2015, Climate change games as tools for education and engagement, *Nature
    Climate Change*, 5, 413-418.

www.climatecentre.org/resources-and-games/games [access: 18.01.2017].

www.climatecentre.org/resources-games/answer-with-your-feet [access: 18.01.2017].

www.ifm-sei.org/files/up/ATACC-publication-web.pdf [access: 18.01.2017].

www.undp.ru/documents/ClimateBoxEng/Climate-box-ENGLISH_an_illustrated_
    textbook.pdf [access: 18.01.2017].

Zahvoyska L., 2011, Education for sustainable development: findings and tasks, *Nau-
    kovyj Visnyk NLTU*, 21(19), 295-303.

## Gry symulujące zmiany klimatyczne jako skuteczne narzędzie w edukacji dla zrównoważonego rozwoju

**Streszczenie.** Zmiany klimatyczne to jeden z najważniejszych problemów, przed jakimi stoi obecnie ludzkość. Tymczasem programy nauczania w szkołach na Ukrainie w większości przypadków nie zawierają aktualnej, praktycznej wiedzy na temat zagrożeń wynikających ze zmian klimatycznych. W artykule przedstawiono przykłady stosowania w szkołach znanych na świecie gier symulujących zmiany klimatyczne. Przeanalizowano je pod kątem przydatności jako narzędzia w edukacji dla zrównoważonego rozwoju (EZR). W badaniu poddano ocenie 12 gier pochodzących z pięciu źródeł działających na zasadzie otwartego dostępu (m.in. WWF, Red Cross Climate Centre). Gry wykorzystano w badaniu pilotażowym przeprowadzonym w pięciu ukraińskich szkołach w celu oceny ich przydatności w programie nauczania w ramach przedmiotów biologicznych. Zastosowanie gier przyniosło istotne efekty w postaci większego zrozumienia zagrożeń wynikających ze zmian klimatycznych oraz wiedzy na temat możliwych rozwiązań. Proponowane gry mogą skutecznie wypełnić lukę edukacyjną w tej dziedzinie.

**Słowa kluczowe:** edukacja na temat zmian klimatycznych, gry ekologiczne, edukacja dla zrównoważonego rozwoju, gry fabularne

Larysa Cherniak*, Margaryta Radomska**

# An Analysis
# of Local Climate Effects:
# A Case Study
# of the Lviv International Airport

**Abstract.** The effect of aircraft emissions on the global climate is a serious long-term environmental issue faced by the aviation industry. As the number of passengers grows, so does the use of jet fuel and the emission of greenhouse gases (GHG). This may destabilize the world's climatic systems, which will consequently lead to global, regional and local environmental, economic and social damage. The Intergovernmental Panel on Climate Change (IPCC) estimates that aircrafts are currently responsible for 3.5 % of the total anthropogenic greenhouse effect. To avoid the negative consequences of climate change, it is necessary to fully understand factors affecting this problem locally and develop methods of mitigating airport climate effects. This article describes and analyses calculations of radiative forcing of aircraft emissions and the radiative impact of clouds in the surrounding area of the Lviv airport. The calculated values were verified against temperature data for the city and at the airport provided by meteorological authorities.

**Keywords:** airport, aircraft emissions, microclimate, greenhouse effect, radiative forcing, climate change

## 1. Introduction

Within the sources and activities across the global economy that produce greenhouse gas emissions, the transportation sector is the third largest emitter of GHGs (the first is power generation and the second is industry), accounting for

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about 13% GHG emissions at a global level and, in particular, about 20% carbon dioxide emissions [Herzog 2009]. Aviation is one mode of transportation that, in turn, is one of many GHG emitting sectors, generating at a global level, over 730 million tons of carbon dioxide per year with an increase of 45% compared to 1990 [Lepore 2009].

The climatic impacts of aviation emissions include: direct climate effects from carbon dioxide ($CO_2$) and water vapor emissions; indirect forcing on climate resulting from changes in distributions and concentrations of ozone and methane as a consequence of aircraft nitrogen oxide (NOx) emissions; direct effects (and indirect effects on clouds) from emitted aerosols and aerosol precursors; and climate effects associated with contrails and cirrus clouds formation [Workshop on the Impacts of Aviation on Climate Change 2006]. In attempting to aggregate and quantify the total climate impact of aircraft emissions the IPCC has estimated that aviation's total climate impact is some 2-4 times over its direct $CO_2$ emissions alone (excluding the potential impact of cirrus cloud enhancement). This is measured as radiative forcing. Globally in 2005, aviation contributed "possibly as much as 4.9% of radiative forcing" [Owen, Lee & Lim 2010].

The IPCC has estimated that aviation is responsible for around 3.5% of anthropogenic climate change, which includes both $CO_2$ and non-$CO_2$ induced effects. The IPCC has produced scenarios estimating, what this figure could be in 2050. The central case estimate is that aviation's contribution could grow to 5% the total contribution by 2050, if actions are not taken to limit these emissions, the highest scenario will be 15% [Lepore 2009]. Moreover, if other industries achieve significant cuts in their own greenhouse gas emissions, aviation's share will definitely stay the same or, which is more likely, will grow.

In Europe, $CO_2$ emissions from aviation have grown by 90% from 1990 to 2005 [Herzog 2009]. If the current trend continue, the growth in emissions from air transport could compromise the achievement of the reductions by the European Union according to the Kyoto Protocol. Moreover, the presence of very busy airport activity has very negative effect on global climate and the environment. For example, in Italy, the European country with highly developed infrastructural facilities, aviation is responsible for 12 million tons of $CO_2$ (8% total emissions from transport) and 68,000 tons of NOx, equivalent to 9% total emitted by the transport sector [Lepore 2009].

Except being the sources of emissions that affect climate, emissions generated by activities occurring inside and outside the airport perimeter associated with the operation and use of an airport, create significant health hazard for people living near airports. In this view, GHGs inventory can become the benchmark, against which the achievement of quantitative targets set at the political level in the fight against climate change and human health hazards are measured [van Begin & van Staden 2011].

The issues of local thermal mode effects of airports are not that well studied as global impact of aviation. To feel this gap this study on the example of the Lviv Danylo Halytskyi International Airport was initiated. The aim of the research is to define the effects of aircrafts' emissions on the temperature mode at the territory of the airport and compare the results with the corresponding situation at the municipal area out of the airport impact zone to validate the contribution of air transportation activity in the formation of local climate parameters values.

## 2. The sources of greenhouse emissions at airports

The composition of emissions at the airport is defined by the activity of power generating facilities, boiling plants, special transport and aircrafts (Table 1).

The aircraft emissions contribution to an airport $CO_2$ inventory typically ranges from 50% to 80% and these are from 2% to 4% of the total global GHG inventory. Based on airport emission inventories prepared to date, emissions from non-aircraft airport-related operations represent an additional 0.1% to 0.3% of the global total [van Begin & van Staden 2011]. In practice, airports use a variety of definitions to determine the aircraft emissions contribution: they can be based entirely on the fuel dispensed at the airport, count the emissions from aircraft only while their wheels are on the ground or include the whole landing and take-off cycle down from and up to an altitude of 900 meters [van Begin & van Staden 2011; Kim, Bassarab, Vigilante & Waitz 2009]. As for our opinion, an airport $CO_2$ inventory must include the landing and take-off cycle, taxiing, and auxiliary power units use.

Other major sources of $CO_2$ at airports are fuel combustion in ground service equipment (GSE) and airside and landside motor vehicles. Airside vehicles include passenger transfer buses and service vehicles, while landside vehicles include passenger and staff transport to and from the airport. Utility plants at airports that burn fossil fuels to produce electricity, heating and cooling can also be large sources of GHG emissions. In Europe, some airports have power generation stations that are already subject to restrictions and emissions trading under the EU's Emissions Trading Scheme. Aviation's overall contribution to the global GHG emissions inventory is dominated by aircraft in flight and these emissions are beyond the control and influence of airports. Discussion here is limited to actions airports can take to address GHG sources within their control and influence.

While the airport contribution can be relatively small, many improvements can still be made. The best approach for addressing aviation's climate change

Table 1. Airport sources of GHG emissions

| Source category | Specific source |
|---|---|
| Aircraft emissions | Aircraft engine emissions before approach above 900 m approach and landing, take-off and initial climb (ground to 900 m), taxiing and queuing (ground). |
| APU | The on-board engine supporting the aircraft while parks on the ground. |
| Ground access vehicles | Include all vehicles traveling to and from, as well as within the airport public roadway system (excluding GSE). On-road and highway vehicles include: vehicles transporting passengers and vehicles using airport parking, vehicles transporting airport employees, including vehicles in employee parking lots, vehicles transporting cargo, airport-owned vehicles. |
| Stationary Sources (Facility Power) | Power/electricity consumption, airport facility boilers, heaters, and generators, aircraft engine testing, maintenance activities (surface coating/painting, degreasing), fuels used by food concessions, etc. |
| Ground support equipment (GSE) | A variety of ground equipment services for commercial aircraft used to unload and to load passengers and to freight at an airport. GSE consist of vehicles that do not leave the airfield: aircraft tugs, air start units, loaders, tractors, air--conditioning units, ground power units, cargo-moving equipment, service vehicles, etc. Off-road vehicles and vehicles that maintain airport facilities are also included. |
| Airport construction activities | Vehicles consuming fuels during the construction process: runway extension or development, terminal building and gate area expansion, new taxiways, etc. |
| Training fires | Fuel usage for planned training activities. Emissions are mostly due to combustion from the burning of the fuel, as well as emissions associated from the use of fire extinguishers or other equipment. |
| Waste management activities | Activities reflect any processes or use of equipment specifically geared toward waste management: sorting of waste, shipping to waste management facilities, recycling, and incineration. |
| Other | All other sources such as local airport companies with industrial processes, farming activities, etc. |

Source: Kim et al. 2009.

emissions, including those from airports, is a long-term strategy that identifies and implements environmentally effective, economically efficient, and politically viable measures for each category of emissions.

## 3. The potential impacts of aviation on ground layers of the atmosphere

Air pollution due to continuous and increasing combustion of fossil fuels for energy has gradually led to the increase of greenhouse gases content in the atmosphere,

thus raising the natural greenhouse effect with anthropogenic component. GHGs, naturally occurring and man-made, include, but are not limited to, water vapor, carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), ozone ($O_3$) and halocarbon compounds containing fluorine (PFCs), chlorine (CFCs, HCFCs) and bromine (halons or sulfur $SF_6$) [Forster et al. 2007]. GHGs in the atmosphere contribute to the greenhouse effect directly when they absorb radiation; on the contrary, indirect effects occur both when greenhouse gases are produced by chemical transformations, and when the atmospheric lifetimes of a gas is influenced by another gas, as well as when a gas affects cloud formations and, more in general, atmospheric processes that alter the radiative balance of the earth.

Most modern jet aircrafts cruise within the altitude range (9-13 km) that include parts of the upper troposphere (UT) and lower stratosphere (LS). Because these two atmospheric regions are characterized with different dynamics and photochemistry, the introduction of aircraft emissions into these regions must be considered when evaluating the impact of emissions on atmosphere structure [Hoinka, Reinhardt & Metz 1993].

Carbon dioxide ($CO_2$) and water vapor ($H_2O$) are the most abundant products of jet fuel combustion (emission indices for $CO_2$ and $H_2O$ are 3.15 kg/kg fuel burned and 1.26 kg/kg fuel, respectively). However, both substances have significant natural background levels in the UT and the LS [Schumann 1994]. Neither current aircraft emission rates nor likely future subsonic emission rates will affect the ambient levels by more than a few percent. Future supersonic aviation, on the other hand (which would emit at higher altitudes), could perturb ambient $H_2O$ levels significantly at cruise altitudes. Regardless of the magnitude of the aircraft emission source, $CO_2$ does not participate directly in ozone photochemistry, because of its thermodynamic and photochemical stability. It may participate indirectly by affecting stratospheric cooling, which can in turn lead to changes in atmospheric thermal stratification, increased polar stratospheric clouds formation, and reduced ozone concentrations.

Aircraft water vapor generation, although relatively small in the troposphere, lead to the atmospheric phenomenon of contrail formation. Depending on the exact composition of contrail particles, which is largely determined by the specific processes occurring in the aircraft plume and by the ambient atmosphere composition and temperature – the particles may act as surfaces for a variety of heterogeneous reactions.

NOx represents the next most abundant engine emission (emission indices range from 5 to 25 g of $NO_2$ per kg of fuel burned) [Report by the IPCC 1999]. With respect to ozone photochemistry, NOx is the most important and most studied component; its aircraft emission rates are sufficient to affect background levels in the UT and LS. Moreover, its active role in ozone photochemistry in the UT and LS has been well recognized.

Aircraft carbon monoxide (CO) emissions are of the same order of magnitude as NOx emissions (i.e., 1-2 g/kg for supersonic and 1-10 g/kg for subsonic aircraft) [Hoinka et al. 1993]. Like NOx, CO is a key participant in tropospheric ozone production. However, natural and non-aircraft anthropogenic sources of CO are substantially larger than analogous NOx sources, thereby reducing the role of aircraft CO emissions in ozone photochemistry to a level far below that of aircraft NOx emissions.

Emissions of sulfur dioxide ($SO_2$) and hydrocarbons from aircraft, at less than 1 g/kg fuel, are significantly less than the more studied emission components discussed above [Report by the IPCC 2004]. Their primary potential impacts are related to formation of sulfate and carbonaceous aerosols that may serve as sites for heterogeneous chemistry. Non-methane hydrocarbon (NMHC) emissions may also contribute to autocatalytic production of NOx, provided that the reactivity of the NHMCs is sufficiently large relative to that of $CH_4$ to overcome their numerical inferiority [Schumann 1994]. However, model studies have indicated that volatile organic emissions from aircraft have an insignificant impact on atmospheric ozone at cruise altitudes [Hoinka et al. 1993].

The climate impacts of the gases and particles emitted and formed as a result of aviation are more difficult to quantify than the emissions; however, they can be compared to each other and to climate effects from other sectors by using the concept of radiative forcing. Because carbon dioxide has a long atmospheric residence time ($\approx$100 years) and so becomes well mixed throughout the atmosphere, the effects of its emissions from aircraft are indistinguishable from the same quantity of carbon dioxide emitted by any other source [Owen et al. 2010].

The other gases (e.g., NOx, SOx, water vapour) and particles have shorter atmospheric residence times and remain concentrated near flight routes, mainly in the northern mid-latitudes. These emissions can lead to radiative forcing that is regionally located near the flight routes for some components (e.g., ozone and contrails) in contrast to emissions that are globally mixed (e.g., carbon dioxide and methane) [Forster et al. 2007].

The global mean climate change is reasonably well represented by the global average radiative forcing, for example, when evaluating the contributions of aviation to the rise in globally averaged temperature or sea level. However, because some of aviation's key contributions to radiative forcing are located mainly in the northern mid-latitudes, the regional climate response may differ from that derived from a global mean radiative forcing. The impact of aircraft on regional and local climate could be important, but has not been assessed.

# 4. The methodology of aircraft emissions thermal impacts calculation

The most useful assessment of the aircrafts impact on climate would be a comprehensive prediction of changes to the climate system, including temperature, sea level, frequency of severe weather phenomena, and so forth. Such assessment is difficult to achieve given the current state of climate models and inability to separate the influence of aviation sector from the global forcing of climate. So, radiative forcing (RF) has been chosen as the one, which is calculated directly from changes in greenhouse gases, aerosols, and clouds, and which provides ready comparison of the climate impact of different aviation scenarios.

For a greenhouse gas, such as carbon dioxide, radiative transfer codes that examine each spectral line of atmospheric conditions can be used to calculate the change $\Delta F$, W/m², as a function of changing concentration [Chung & Soden 2015]. These calculations can often be simplified into an algebraic formulation that is specific to that gas. For instance, the simplified first-order approximation expression for carbon dioxide is:

$$\Delta F = 5.35 \times \text{lh} \frac{C}{C_0}$$

where C is the $CO_2$ concentration in parts per million by volume and $C_0$ is the reference concentration. The relationship between carbon dioxide and radiative forcing is logarithmic, and thus increased concentrations have a progressively smaller warming effect [Chung & Soden 2015; Gregory et al. 2004].

The calculation procedure, developed by the authors, includes calculation of total $CO_2$ emissions, produced by aircrafts flying at an airport taking into account their forcing fuel consumption. Then, the final concentration of carbon dioxide in the air of the airport was calculated, supposing that 20-33% of the gas is blown away from the territory of airport and the calculated air volume is limited with the borders of airport to the height of 900 m, or the boundary layer [Kim et al. 2009].

The algorithm of defining temperature increase over the airport territory, conditioned by concentration of $CO_2$, was offered to include the following steps:

1) Defining the mass of fuel spent by each type of aircraft.

2) Calculation of the amount of $CO_2$ produced by aircrafts per day, supposing that per each kg of jet fuel, consumed by aircraft, 3.157 kg of $CO_2$ are formed.

3) Defining total mass of carbon dioxide produced per day at airport ($C_{CO_2}$), mg/m$^3$, accounting the area of an airport and the height of the boundary layer, forming together the study volume.

4) Recalculation of the resulted value into ppm – parts of $CO_2$ per 1000000 parts of atmospheric air:

5) Accounting background concentration of $CO_2$ (which makes 380 ppm) after recalculation of $CO_2$ concentration into ppm, this is done by adding it to the obtained value.

6) Defining the factor of "radiative forcing," which is formed as a result of air traffic at the airport, using the above mentioned formula [Chung & Soden 2015].

7) Definition of the resulted temperature increase over the airport territory, conditioned by this concentration of $CO_2$ [Gregory et al. 2004]:

$$\Delta T_S = \lambda \times \Delta F$$

where $\lambda$ – is a climate sensitivity, which is established to be $\lambda = 0,8 \text{ K}/(\text{W} \times \text{m}^2)$.

## 5. The characteristics of the studied object

Lviv Danylo Halytskyi International Airport is an international airport in Ukraine with passenger overflow near 600 thousands people per year. It has direct con-

Table 2. The number of flights for the 2015

| Month | Number of flights | International flights | Domestic flights | Peak month |
|---|---|---|---|---|
| January | 645 | 454 | 191 | Peak |
| February | 555 | 379 | 176 | – |
| March | 589 | 400 | 189 | Peak |
| April | 577 | 382 | 195 | – |
| May | 581 | 455 | 126 | – |
| June | 706 | 539 | 167 | – |
| July | 803 | 615 | 188 | – |
| August | 845 | 663 | 182 | Peak |
| September | 743 | 565 | 178 | Peak |
| October | 594 | 438 | 156 | – |
| November | 530 | 376 | 154 | – |
| December | 540 | 371 | 169 | – |

Source: Official website of the Lviv Danylo Halytskyi International Airport, 2015.

nection with the cities all over the world such as: Munich, Dortmund, Vienna, Warsaw, Krakow and Wroclaw, Moscow and Surgut, Naples, Venice and Milan, Prague, Hurghada, Istanbul, Kyiv and others.

The perspectives of transportation volumes growth in the upcoming years raises the question about climate effects of increased traffic [IATA 2014]. The prognosis of air transportation growth up to 2035 year supposes that volume of transportation will double. With increasing number of flights the environmental situation at airport will be getting worse.

Lviv Danylo Halytskyi International Airport carries out both international and domestic flights. To analyze the potential climate effects of air flights in the airport intensity of air transportation was studied during one year (Table 2).

## 6. The results of the Lviv airport temperature mode changes under the influence of air traffic

Based on the technique, presented above, the gross emissions of aircrafts at the territory of Lviv airport by days were calculated. As it could be seen from the table the busiest months and correspondingly the most intensively polluting the ground layer atmosphere are July and August, followed by June and September.

The resulted total radiative forcing of aircrafts emissions by days shows that the maximal values are typical for July and August. Due to radiative forcing the increase of temperature at the airport vicinity is observed (Table 3). This number reaches 1.34 degree at the busiest August days. In average the increase of temperature is 0.8–1.2 degree at days with high flight intensity and 0.6–0.8 at not busy days.

The activity of air transportation processes affect on thermal mode as we try to prove with our calculations, so there is need to analyze the weather regime at the territory of Lviv Danylo Halytskyi International Airport as compared to Lviv municipal area. Having analyzed the information about the temperature levels in Lviv Danylo Halytskyi International Airport and Lviv municipal area, we have established, that there is noticeable difference between them: the average temperatures ranges from 0.61°C in September to 1.7°C in July.

The radiation strengthening due to clouds (which is 1.1) have to be added to the value of temperature increase over the airport territory, conditioned by this concentration of $CO_2$ in cloudy days. As a result the radiative forcing rises to the range 1.2–2.3°C.

Table 3. Total radiative forcing of aircrafts ($\Delta T$)

| Days | April | May | June | July | August | September | October |
|------|-------|-----|------|------|--------|-----------|---------|
| 1 | 0.978 | 0.890 | 1.129 | 1.109 | 0.835 | 1.275 | 0.945 |
| 2 | 1.009 | 0.516 | 1.117 | 1.368 | 1.515 | 1.109 | 1.277 |
| 3 | 0.972 | 0.930 | 1.109 | 1.277 | 1.547 | 1.505 | 0.405 |
| 4 | 0.763 | 0.991 | 1.213 | 0.835 | 1.275 | 1.277 | 1.224 |
| 5 | 1.003 | 1.117 | 1.119 | 1.515 | 1.109 | 0.835 | 1.229 |
| 6 | 0.972 | 0.803 | 0.505 | 1.453 | 1.410 | 1.515 | 1.117 |
| 7 | 1.041 | 0.777 | 1.364 | 1.275 | 1.277 | 1.453 | 1.109 |
| 8 | 0.966 | 0.981 | 1.129 | 1.109 | 0.835 | 1.275 | 0.945 |
| 9 | 0.872 | 0.566 | 1.275 | 1.408 | 1.515 | 1.109 | 1.119 |
| 10 | 0.972 | 0.930 | 1.109 | 1.277 | 1.678 | 1.408 | 0.405 |
| 11 | 0.665 | 0.991 | 1.213 | 0.835 | 1.275 | 1.277 | 1.224 |
| 12 | 1.089 | 1.117 | 1.119 | 1.515 | 1.109 | 0.835 | 1.129 |
| 13 | 0.972 | 0.803 | 0.663 | 1.547 | 1.410 | 1.515 | 1.117 |
| 14 | 1.041 | 0.945 | 1.364 | 1.275 | 1.277 | 1.547 | 1.109 |
| 15 | 0.966 | 0.981 | 1.300 | 1.109 | 0.835 | 1.117 | 0.945 |
| 16 | 0.872 | 0.516 | 1.275 | 1.410 | 1.515 | 1.109 | 1.119 |
| 17 | 0.972 | 1.089 | 1.109 | 1.277 | 1.453 | 0.945 | 0.405 |
| 18 | 0.665 | 0.991 | 1.254 | 0.835 | 1.275 | 1.277 | 1.070 |
| 19 | 1.089 | 1.117 | 1.277 | 1.515 | 1.109 | 0.663 | 1.129 |
| 20 | 0.809 | 0.970 | 0.663 | 1.586 | 1.543 | 1.515 | 1.117 |
| 21 | 0.881 | 0.945 | 1.515 | 1.275 | 1.358 | 1.586 | 0.777 |
| 22 | 0.803 | 0.981 | 1.397 | 1.109 | 0.835 | 1.117 | 0.777 |
| 23 | 0.706 | 0.566 | 1.275 | 1.505 | 1.515 | 1.109 | 1.119 |
| 24 | 0.809 | 1.044 | 1.109 | 1.277 | 1.547 | 1.049 | 0.405 |
| 25 | 0.492 | 0.991 | 1.271 | 0.835 | 1.275 | 1.277 | 1.089 |
| 26 | 0.930 | 1.117 | 1.277 | 1.515 | 1.109 | 0.663 | 0.809 |
| 27 | 0.991 | 0.970 | 0.835 | 1.453 | 1.410 | 1.224 | 0.881 |
| 28 | 1.050 | 0.945 | 1.515 | 1.275 | 1.358 | 1.287 | 0.803 |
| 29 | 0.803 | 0.981 | 1.586 | 1.109 | 0.835 | 1.117 | 0.706 |
| 30 | 0.706 | 0.505 | 1.275 | 1.543 | 1.515 | 1.109 | 1.109 |
| 31 | – | 1.089 | – | 1.277 | 1.586 | – | – |

Source: authors development.

## 7. The potential climate effects of airports and their environmental consequrences

There are several environmental effects due to airport activity, among them are:
   – Increasing of frequency and intensity of climate anomalies and extreme weather phenomena.
   – Droughts that genetically peculiar to a climate of Ukraine are becoming more frequent and more intense.
   – Further spread of new types of diseases of crops, pests and weed.
   – Worsening of problems with water supply of southern and south-eastern regions of Ukraine.
   – The increase in morbidity and mortality due to changes in temperature.
   – Forest productivity reducing.
   – Irreversible changes in ecosystems [Shevchenko 2014].
   These effects are valid at national and regional levels, but they could be also displayed at local levels in the vicinity of major airport.
   The damage from climate effects might be assessed directly or indirectly in monetary value. The direct assessment is possible accounting the price of carbon unit, which is a ton of $CO_2$ and cost 13.75 USD as for the prices of 2010, 21.35 USD in 2015, and by 2020 it will be 32 USD [Shevchenko 2014]. Thus, the cost of monthly $CO_2$ emissions represents the environmental losses, which could be deducted from airport incomes make up from 80184.2 in April 2015 to 11370.1 in September. The estimation of cost of generated carbon units shows that there are 703 thousand UAH for the period of 2015 year from April to October could be dedicated from airport incomes. This money could be spent on greening of the airport territory for catching some part of $CO_2$ emissions or for other environmental purposes.

## 8. The approaches to mitigation of airport environmental effects

The adoption of measures to prevent, minimize or mitigate adverse impact of aviation on climate is the main target of airport stakeholders; today more than ever they are called upon to assess the local air quality at and around the airport. Assessment should be based on air quality regulation or standards to determine if the current or planned airport activities are expected to comply with the

applicable regulations for each pollutant species. There are three main types of actions:

1. Measurements of the concentrations of specific pollutants of concern;

2. Development of inventories of emission sources to quantify the airport and airport-related sources for each pollutant;

3. Assessment of the expected pollutant concentrations at receptor locations by dispersion modeling [Berry, Gillhespy & Rogers 2008].

Mitigation of local air quality pollution is best achieved by reducing emissions at source. To reduce emissions the following measures are offered to be done:

– regulate the amount of emissions by setting emissions standards on sources or prescribing restrictions on operations (regulatory measures);

– reduce emissions through the implementation of technical solutions (technical measures);

– influence the emission levels through reducing fuel consumption or changing operating times of emissions sources or procedures (operational measures);

– create economic incentives to change activities or equipment with lower emissions (economic or market-based measures), including local emission charges and global or regional emission trading schemes.

These can be also implemented as a combination of several categories of measures. For emissions reduction opportunities, or where reductions in the adverse impact of aviation on climate change can be achieved, it is therefore important to distinguish between aircraft emissions and those emissions directly associated with airports. Moreover, particularly in the development of greenhouse gas emissions inventories, responsibility or ownership and location (on and off airport) have to be clearly demarked. Then, an airport has to develop goals and action plans to achieve the ultimate target of being carbon neutral [Berry et al. 2008].

Airport Council International Policies and Recommended Practices Handbook identify approaches to minimize or mitigate the adverse impacts of aviation on climate change:

1. Airports should develop inventory of airport and airport-related GHG emissions.

2. Goals and action plans should be developed with the ultimate target of becoming carbon neutral.

3. Reductions in aircraft taxiing, queuing and APU usage reduce GHG emissions.

4. Airports should review GSE and ground vehicles (airside) as well as ground vehicles (landside) and land transport for GHG emissions reduction opportunities.

5. New buildings should employ best practice energy efficiency and GHG technology:

– underground thermal sinks can be used to enhance heating and cooling efficiencies.

– combined cooling, heat, and power systems use waste heat from electricity generation to heat the terminal in winter. In summer, absorption cycle refrigeration systems can use the same heat source to generate chilled water to cool the building.

– smart building technologies can be used to reduce lighting and heating or cooling in unoccupied spaces. Unoccupied escalators can be slowed or paused until people need to use them.

– for large interior spaces in hot climates, thermal stratification can be used to cool occupied areas at floor level while allowing unoccupied space near the ceiling to remain hot.

– in cold climates, new steam plume-suppressing technologies can be used to allow heating plants to be located close to terminal and control tower structures without affecting visibility. This can substantially reduce piping losses and inefficiencies.

6. New and existing buildings should have best practical thermal insulation and glazing:

– installation of shading or light-filtering films on windows to reduce solar load.

– modifying and modernizing heating, ventilation and air-conditioning systems, such as installing variable speed electric motors to reduce air flows when occupancy is low or temperatures are mild.

– installation of more efficient and long-life light bulbs for both interior and exterior lighting.

7. Operational procedures can also be used to improve energy efficiency:

– maintenance hangar door opening and closing procedures can be improved to reduce heat loss in winter or heat gain in summer.

– lighting procedures can be improved to minimize lighting in unoccupied areas or during low occupancy.

8. Renewable energy should be used, where practicable, to reduce fossil fuel consumption.

# 9. Conclusions and discussions

Airports are sources of emissions that affect climate. Having analyzed the information about the temperature levels in Lviv airport and Lviv municipal area, it was established, that there is noticeable difference between them – temperature difference reach 1-3°C.

Radiative forcing formed as a result of air traffic of the airport depends on the number of flights. The value of forcing reaches 1.34 degree at the busiest August days. On average the increase of temperature is by 0.8–1.2 degree during the days with high flight intensity and 0.6–0.8 during not busy days.

The prognosis of air transportation development at Lviv airport that based on information from 2004 to 2015 years, shows that passenger overflow will double by 2025 [Polyarush & Tarasova 2010]. With increasing of number of flights the environmental situation at airport will getting worse.

The estimation of cost of monthly $CO_2$ emissions shows that over 703 thousand UAH for the period of 2015 year from April to October could be deducted from airport incomes. This money could be spent on greening the airport territory, catching some part of $CO_2$ emissions or for other environmental purposes.

There is a range of policy options being considered at governmental level and instruments such as ICAO engine emission standards to help in reducing aircraft fuel consumption and greenhouse gas emissions. However, because the science on the relative climate effects of altitude, contrails and NOx is not yet fully understood, the evaluation of potential policy solutions with the certainty of a positive result is incomplete. Moreover, the observed and assessed thermal effects were considered for a limited period of time, which does give possibility to make final conclusions about the continuous effects of air traffic on local climate. The further investigations will be aimed at defining regularities of thermal mode fluctuations at airport territory on the annual basis. Nevertheless there is a lot that can be done to reduce fuel consumption, which reduces climate change effects of air transportation:

– making routes more direct;
– aiming for a fuel optimised flight profile;
– increasing load factor and capacity (and use) of more fuel optimised routes;
– operating more fuel efficient aircraft;
– avoid holding and queuing aircraft with engines running (in the air and on the ground);
– avoid restrictions and procedures that do not achieve sufficient benefits compared to the other environmental disadvantages;
– using effective fuel optimised speeds when circumstances change.

## References

Begin G. van, Staden M. van, 2011, *Harmonisation in inventories. City typology as the basis for policy*, 2010 KPMG Advisory N.V. in the Netherlands.

Berry F., Gillhespy S., Rogers J., 2008, Airport Sustainability Practices. A Synthesis of Airport Practice. *ACRP Synthesis Report 10 (1ˢᵗ ed.)*, Washington DC: Transportation Research Board.

Chung E.S., Soden B.J., 2015, An assessment of methods for computing radiative forcing in climate models. *Environmental Research Letters*, 10(7): 1-8.

Gregory J.M., Ingram W.J., Palmer M.A., Jones G.S., Stott P.A., Thorpe R.B., Lowe J.A., Johns T.C., Williams K.D., 2004, A new method for diagnosing radiative forcing and climate sensitivity. *Geophysical Research Letters*, 31: L03205.

Forster P., Forster P., Ramaswamy V., Artaxo P., Berntsen T., Betts R., Fahey D.W., Haywood J., Lean J., Lowe D.C., Myhre G., Nganga J., Prinn R., Raga G., Schulz M., Dorland R. van, 2007, Changes in Atmospheric Constituents and in Radiative Forcing, in *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge – New York: Cambridge University Press.

Hoinka K.P., Reinhardt M.E., Metz W., 1993, North Atlantic air traffic within the lower stratosphere: cruising times and corresponding emissions, *Journal of Geophysical Research*, 23: 113-131.

Herzog T., 2009, World Greenhouse Gas Emissions in 2005, WRI Working Paper, World Resources Institute.

IATA , 2014, *New IATA Passenger Forecast Reveals Fast-Growing Markets of the Future*, Press Release No. 57, October, 16.

Kim B., Bassarab R., Vigilante M., Waitz I.A., 2009, *Appendices to ACRP Report 11: Guidebook on Preparing Airport GHG Emissions Inventories*.

Lepore A., 2009, *Attack on climate: from the sky and the sea!*, Roma: Greenpeace Italy.

Owen B., Lee D.S., Lim L., 2010, Flying into the Future: Aviation Emissions Scenarios to 2050, *Environmental Science & Technology*, 44: 2255-2260.

Polyarush M.M., Tarasova I.I., 2010, Analysis and assessment of air transportation in Ukraine and perspectives of their development, *Proceedings of the Vynnytsya Trade and Economic Institute*, 3: 49-54.

Report by the Intergovernmental Panel on Climate Change: Aviation and the Global Atmosphere, 1999, Cambridge: Cambridge University Press.

Report by the Intergovernmental Panel on Climate Change: Aviation and the Environment, 2004, *Report to the United States Congress*.

Schumann U., 1994, On the effect of emissions from aircraft engines on the state of the atmosphere, *Annales Geophysicae*, 12: 365-384.

Shevchenko O., 2014, *The assessment of climate change vulnerability: Ukraine*, Climate Forum of Eastern Partnership and NGOs working group on climate change.

Workshop on the Impacts of Aviation on Climate Change, 2006, *A Report of Findings and Recommendations*, June, 7-9, Cambridge, Mass.

## Wpływ funkcjonowania lotniska na zmiany klimatu na przykładzie Portu Lotniczego Lwów

**Streszczenie.** Wpływ emisji spalin z silników samolotów na klimat Ziemi to poważny problem dla przemysłu lotniczego. Wraz ze wzrostem liczby pasażerów rośnie zużycie paliwa lotniczego oraz emisja gazów cieplarnianych (GHG). Może to destabilizować światowe stosunki klimatycz-

ne, a w konsekwencji powodować szkody środowiskowe, ekonomiczne i społeczne na skalę globalną, regionalną i lokalną. Według szacunków Międzyrządowego Zespołu ds. Zmian Klimatu (IPCC) samoloty są odpowiedzialne za 3,5% antropogenicznego efektu cieplarnianego. Aby zapobiec negatywnym skutkom zmian klimatycznych, konieczne jest poznanie czynników wpływających na to zjawisko na poziomie lokalnym oraz opracowanie metody zmniejszania skutków klimatycznych związanych z działalnością lotnisk. W artykule przedstawiono obliczenia i analizę wartości wymuszania promieniowania związanego z emisjami samolotowymi oraz wpływu promieniowania chmur na obszarze Portu Lotniczego Lwów. Obliczone wartości zostały zweryfikowane przez porównanie z danymi meteorologicznymi dotyczącymi temperatury w mieście i na terenie lotniska.

**Słowa kluczowe:** lotnisko, emisje samolotowe, mikroklimat, efekt cieplarniany, wymuszanie promieniowania, zmiany klimatyczne

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