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RESEARCH ARTICLE

SUSTAINABLE ECOLOGICAL EDUCATION AND ENVIRONMENTAL EDUCATION IN BIOLOGY

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ABSTRACT

This research on sustainable ecological and environmental education has been realized with students from BIOTERRA University of Bucharest and with high school students from *Ion Luca Caragiale (ILC) National Collegium* from Bucharest, being used qualitative and quantitative research methods. The research on ecological education and environmental education shows the correlation between them, and for sustainable them are very necessary to develop and complementarity of the three types of education-formal, non-formal and informal. Sustainable formal ecological education and environmental education, realized in framework of the courses, seminars, practical laboratory work, lessons involve numerous educational ways, by applied of practical-heuristic and interactive methodologies based on participation-active methods, student-centered methods, mainly on investigations and projects maked by students in team and group. Also, has been applied and identified as better didactical ways, the SMART methodologies with of aid of Information and Communication Technologies (ICT) and of numerous modern methods, e.g. Computer-Assisted Instruction (CAI) through applications of the *High School Educational Assistance (HSEA)*, multi-media demonstration, practical electronic works correlated to modeling of some object models with aid of electronic means, what is constituted in smart methodologies, through which can be realized Smart Sustainable Ecological and Environmental Education. All these methodologies identified, respectively the practical-heuristic and interactive methodology and SMART methodology brings one cognitive and affective plus, contributing to sustainability of ecological and environmental education, to sustainable and SMART education, demonstrated by results of assessment tests.

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INTRODUCTION

The purpose and objectives of the work: To the latest World Environmental Education Congress, the 9th, which have takes place in September 9-15, 2017 in Vancouver, Canada, with the United Nations Educational, Scientific and Cultural Organization (UNESCO) patronage, an international congress addressing education for environment and sustainability, have approached the latest themes in environment education and sustainability, this being a major concern for humanity. The Official Agenda for Sustainable Development adopted on 25 September 2015 present seventeen Sustainable Development Goals, among which and: Education-Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all; Ecosystems-Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, and halt and reverse land degradation and halt biodiversity loss (United Nations, 2015a). Existence of Terra planet is possible with people with a good level of general education (Latin, *Educo-educare-educere* to increase, to grow, to guide, *Educatio*-growing, guidance, education), including the ecological education and environmental education through traditional means, e.g. the practical work devices, the experiment devices, but and through modern means, e.g. the projects, the Information and Communication Technologies (ICT), that reflecting a SMART education which contribute to sustainability education and environment. Ciobanu, (2009) consider that the environment is an important problem that we must think, reflect, find solutions to ensure its health and that one solution is ecological, formal, non-formal and informal education. This paper presents the research of the didactical methodologies that contribute at achievement of ecological education and environmental education of students in teaching and learning of Biology (bios = life, logos = science, speech). Also, this paper presents and about non-formal and informal ecological and environmental education. The purpose of study, respectively the identification of the teaching and learning methodologies to achieve of ecological and environmental education, by Biology, the scientific objectives being:

- Reconstruction of conceptualization and of teaching and learning methodologies for achieving ecological and environmental education of students;

- Identification of methodologies and examples of ecological and environmental education.

Obtaining a quality education is the foundation of improving people's lives and sustainable development (United Nations, 2015b). United Nations (1987) consider that the sustainability is our shared future and that the current sustainable development must not compromising the skill of future generations to satisfy their own needs, but with the rapid progress in technology, how to manage technological risks has been added as a new dimension to the problem of how to sustain human society long into the future (Bostrom, 2013; Posner, 2004; Rees, 2004). For sustainable development of *Knowledge Society*, the realization of a sustainable ecological and environmental education based on practical interactive activities in Nature, on correlation between man and Nature, but and based on electronic learning and ICT, when natural conditions of environment and weather do not allow otherwise, being necessary namely SMART Sustainable Education which have a fundamental role in learning, in the potentiating of the didactical methodologies applied, including in the study of biological disciplines, that make the object of this research. In according with Brody (2005), Puk and Stibbards (2012), the fieldwork, field trips and nature studies, are important ways of improving ecological literacy, i.e., "understanding the key ecological systems using sound ecological thinking, while also understanding the nature of ecological science and its interface with society" (Berkowitz *et al*., 2005).

Also, these contribute to connectedness to nature, as have showed Arnold *et al*. (2009), Ernst and Theimer (2011), to positive environmental attitudes, as have found Rios and Brewer (2014), and to environmental consciousness, in according with Nazir and Pedretti (2016). Many of the topics in biology are closely linked to the content of Sustainability Education, especially in the fields of ecology, biodiversity, conservation and system biology. According to Palmberg *et al*. (2015), the ability to identify species is important for a better understanding of biodiversity and issues concerning the environment and sustainability, not only for comprehension of certain branches of biology (e.g., ecology, evolution, genetics). Stugren (1994) consider that Ecology is the science of life interactions with the environment on over-organisms levels and responds to a social imperative to educate students and young people in the spirit of not only caring for and preserving the natural beauty and trophic chains and worldwide, but also reasonably exploiting all the resources and riches of the country and the sustainable development through the creation of viable economic growth solutions in balance with the solutions created for environmental protection. Developing a relationship with nature is an important precursor to understanding sustainability (Palmer and Suggate, 1995; Bögeholz, 2006). Environmental education is a branch of ecology. Mohan and Ardelean (1993) emphasize that environmental education should develop all people attitudes of respect and responsibility towards the natural resources.The study of essential issues tackled in teaching ecological concepts include the properties of diverse natural and anthropic ecosystems, forms of environmental destruction, pollution effects on living organisms, environmental protection, biodiversity preservation, and contribute to the shaping and development of an ecological consciousness and way of thinking and of a pro-active attitude towards the protection and conservation of the ecosphere, as in educational trends in several EU countries, such as France, England, Sweden or the Netherlands. Bontaş (1998) consider that are 3 main forms of education, namely formal, non-formal and informal, which are also applicable in ecological education and environmental education. Formal (Lat. formalis=pertaining to shape, accurade, valid, legally organized, formal) ecological education and environmental education mean the regular inclusion of ecological education and environmental educational activities in the instructive - educational teaching process, respectively in courses, seminars, laboratory work, lessons, following the specialization programs in relevant universities or national curriculum, the school curriculum.
In teaching of Biological Sciences is very necessary the effective use of informational content in the ecological education and environmental education, that must be fully exploited. Biology lessons taught in high schools aim at developing a certain ecological culture which should lead to a vital ecological behavior towards nature and help to understand the environment and the living organisms that surround us and influence the life. At academic level, Biology taught within disciplines such as *Ecology and Protection of Environment, General Microbiology, Biochemistry* etc. aim at improving this environmentally-friendly behavior by utilization of interactive courses, projects, investigations, computers and software programs, CAI and Internet, electronic practical works, fishbowl, debates and open discussions and so on. Derevenskaia (2014) consider that the application of modern educational technology and active learning in environmental education is phenomenally significant, as far as they can be used to assure training and professional orientation of students. But, Cerghit (2006) pointed out that is up to the teachers to pronounce options for methods finded to be more suitable and efficient in a given situation.

MATERIALS AND METHODS

To this research *Sustainable ecological and environmental education in Biology* has involved 166 students from BIOTERRA University of Bucharest in 2012-2013 and 2013-2014 university years and 110 students from *Ion Luca Caragiale (ILC) National Collegium* from Bucharest, in 2016-2017 intervals, involved in pedagogical experiment. Also, in this paper has presented the project *Combating the pollution!* with 330 beneficiaries from Bucharest, young and adults, derulated in repetable mode in many years. Out of the 166 students, 16 students from the second year of the Faculty of Food Control and Expertise and the Faculty of Food Products Engineering at the BIOTERRA University in Bucharest non-formal performed at Biochemistry, beyond the courses and practical works, a scientific research on the quality of the natural environment, the quality of the social environment and the quality of life contributing to their professional education, ecological and environmental education, to their food education, the topic of research being *Melliferous plants-bees-honey of bees-human-society correlation and its role in ecological education and environmental education of students*.
Some students have actually participated in practical experiments to highlight honey of bees' falsification/polluted, or others have developed and administered a questionnaire on environmental degradation, pollution and environmental protection etc. Then they all participated in the concrete awareness of the need to protect the environment, to preserve a clean, unpolluted environment. For this last stage of research, several students have been concerned with creating flyers with educational themes, ecological education, environmental education, and food education, all of these aspects of education

contributing to their professional education. The research methods used are data collection methods, that are quantitative and qualitative methods, but and data processing methods. The most important data collection methods:

- The study of specialty bibliography; some of the students involved in this research have documented about melliferous plants, pollution, honey of bees, national and international environmental policies, environmental quality standards, quality standards for *honey of bees*, international and national legislation on the environment.
- The questionnaire; some of the students involved in this research administered a student questionnaire on:
- The significance of the correlation *melliferous plants-bees-honey of bees-man-society*;
- Pollution of the environment and combating environmental pollution and honey of bees pollution;
- Students' considerations regarding honey quality standards, to environmental standards;
- recognition of counterfeited honey, polluted honey;
- The preference for a certain honey bee assortment and the considerations regarding its importance to human health, etc.;

They completed the questionnaire 150 students from all faculties of BIOTERRA University of Bucharest and all the years of study.

- The pedagogical observation; the researcher have conducted systematic pedagogical observations of students behavior in ecological lessons; to increase the efficiency of using this method of pedagogical research, the researcher used grids to observe students' behavior during lessons, which were previously prepared for lessons, including, among others, tracking students' skills with computer; as attitudes, the researcher watched the pupils' ecological attitudes, attractiveness towards ICT, the satisfaction of activities, curiosity and epistemic interest, etc;
- The pedagogical experiment; this was carried out with 4 high school students groups (110 students) from *ILC National Collegium*, with which the BIOTERRA University is in partnership, and whom were taught ecology lessons by SMART methodologies based on ICT, but and by practical-heuristic and interactive methodologies based ob investigation, projects; the students involved in this research from Faculty of Food Control and Expertise and the Faculty of Food Products Engineering carried out the organoleptic examination, the physico-chemical exam and the microbiological examination of 100 different samples of honey for identification if they are polluted/counterfeit;
- The testing method; the initial testing consisted of an assessment test of the biological and ecological knowledge studied in the previous year, given at the beginning of the first semester; throughout the research, has been applied current assessment tests in ecological lessons realized by SMART methodologies based on ICT, but and by practical-heuristic and interactive methodologies based on investigation, projects; and at the end of the research the researcher applied a summative (final) assessment test of the ecological knowledge assimilated during of the research;
- The discussion.

The data processing methods used in this research were

- Mathematical methods: calculation of overall average, of frequency of scores; the percentage calculation method; has been calculated the overall average of initial assessment sample, the overall average obtained from current assessment samples and the overall average of final assessment sample;
- Graphical methods: diagrams;
- Logical methods, allowing the selection of the material, its ordering: analysis, synthesis, induction, deduction, analogy, method of difference.

RESULTS AND DISCUSSION

Statistical data

Statistical data of applying of SMART methodologies and practical-heuristic and interactive methodologies to Biology: The SMART methodologies based on ICT, in mainly as the activities of students with the help of computers and of Computer-Assisted Instruction (CAI) method, but and the practical-heuristic and interactive methodologies based on investigations, and projects applied to Biology, in *Human Ecology* chapter, grow the results of students and ecological and environmental education. Such, in 2016-2017, at *ILC National Collegium*, has been applied the SMART methodologies based on ICT by CAI method, multi-media demonstration, observation, electronic practical work, modelling, with the help of the computers, of the educational software *Biology Interactive Lessons*, of *High School Educational Assistance (HSEA)* applications, of the video projector, of the smart board, but also practical-heuristic and interactive methodologies based in mainly on investigations and projects of students from this research in team and in group. By applied of this methodologies, the overall average of the summative assessment is higher than the overall average of the initial assessment, increasing from 8.05 to 9.20, at XIIth C class, from 8.30 to 9.33, at XIIth D class, from 8.27 to 9.35, at XIIth G class (Fig. 1), and also, increasing the overall average of currents assessments compared to the overall average of initial assessment which show the efficiency and the functionality of this methodologies identified and applied.

IA-overall average of initial assessment sample (8.05-XIIth C class, 8.30-XIIth D class, 8.27-XIIth G class)
CA-Current assessment
CA1-overall average obtained to current assessment sample 1 (8.35-XII C, 8.72-XII D, 8.82-XII G)
CA2-overall average obtained to current assessment sample 2 (8.60-XII C, 8.90-XII D, 8.95-XII G)
CA3-overall average obtained to current assessment sample 3 (8.80-XII C, 9.10-XII D, 9.15-XII G)
CA4-overall average obtained to current assessment sample 4 (9.05-XII C, 9.25-XII D, 9.20-XII G)
FA-overall average of final assessment sample (9.20-XIIth C class, 9.33-XIIth D class, 9.35-XIIth G class)

Statistical data of questionnaire applied to students: In correlation with the question about the pollution of the environment, combating environmental pollution and combating of pollution of honey of bees, administered to 150 students from BIOTERRA University of Bucharest, questionnaire being prepared by some students, 60.5 % from

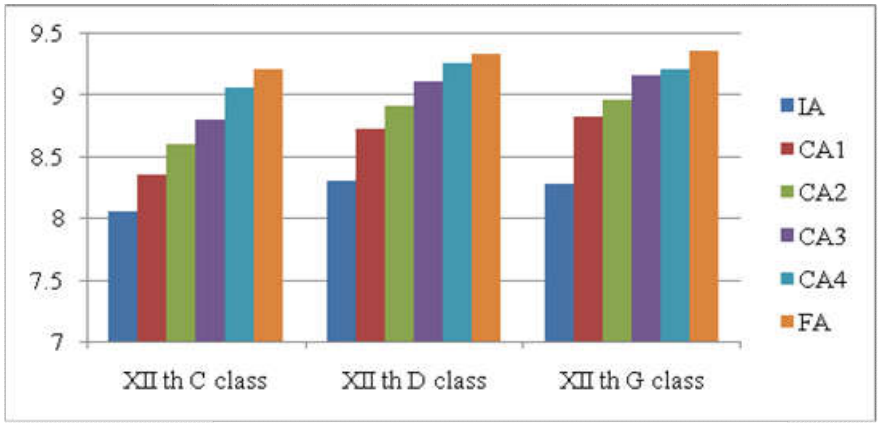

Fig. 1. Histogram of the results obtained to the initial assessment, currents assessments 1, 2, 3, 4, and final assessment, to XIIth C, D and G researched classes

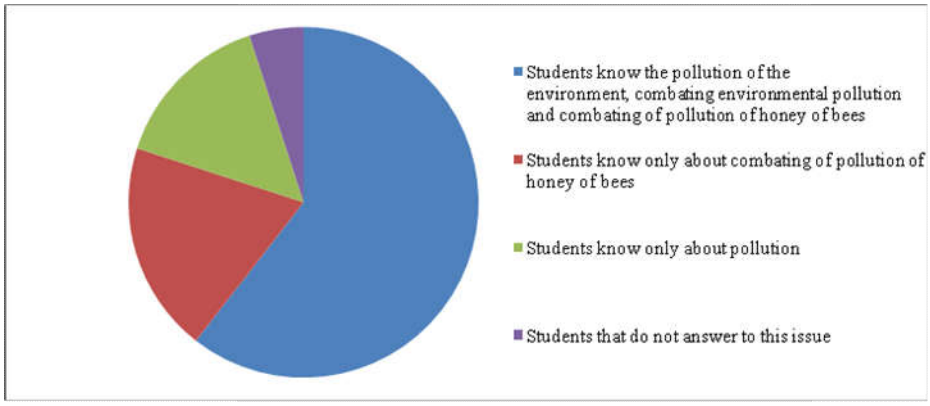

Fig. 2. Diagram of students' answers to question about pollution of the environment, environmental pollution combating and of honey of bees pollution combating

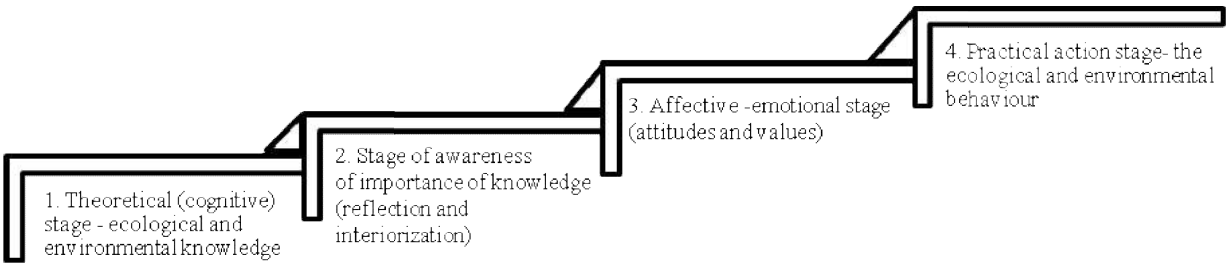

Fig. 3. Stages in ecological and environmental education (scheme)

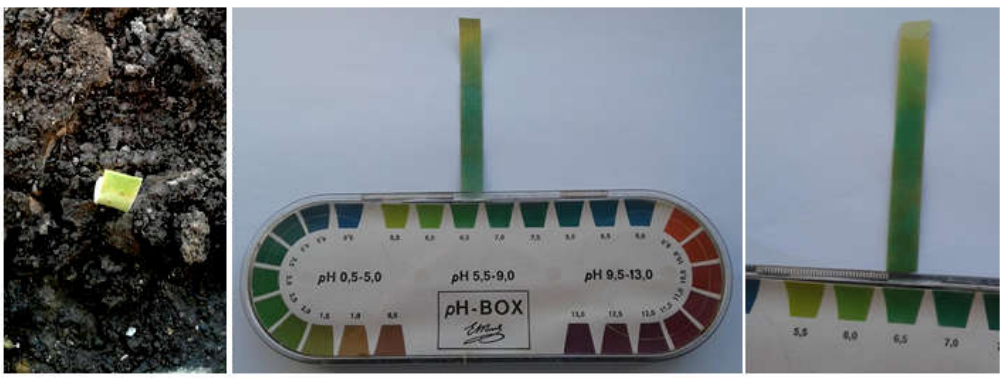

Fig. 4. Soil pH determination with pH indicator paper a) pH indicator paper introduced in soil; b) comparision of the pH indicated by pH indicator paper introduced in soil and pH indicator scale: pH between 6.5 and 7.00; c) pH indicator paper introduced in soil indicate the pH 6.5.

Fig. 5. Cleaning the residues on soil!

Table 1. SMART methodology applied in the *Terrestrial anthropisation ecosystems* lesson

Cur. N°.	*Content of lesson*	*SMART methodology applied*
1.	Terrestrial anthropisation ecosystems: herbaceous plant crops, fruit trees and shrubs plantations, protected crops, zootechnical intensive livestock breeding complexes, rural and urban settlements - characteristics, biotope and biocoenosis particularities, interspecific relations, determination of trophic structure-chains, networks and trophic pyramids.	Demonstration of images and films with annual and biannual herbaceous crops, plantations of fruit trees and shrubs, with intensive animal breeding complexes of domestic animals, of bird breeds, pig breeds, cows, rural and urban settlements with the help of video projector, computer, DVD, SMART board (frontal activity). Applications of the *HSEA* (computers, *Interactive Biology Lessons - volume I* software) correlated with the electronic realization of models of trophic chains, trophic pyramids, trophic network for annual and biannual herbaceous crops, plantations of fruit trees and shrubs, protected culture, for zootechnical intensive livestock breeding complexes (individual activity). Electronic practical work and modeling of trophic pyramid object model for one herbaceous plant crop/zootechnical intensive livestock breeding complexes/rural and urban settlements, by used the laptop, computer program, 3D printer and recyclable plastic materials (activity in team).

respondents students know the pollution of the environment, combating environmental pollution and combating of pollution of honey of bees, 19.5% know only about combating of pollution of honey of bees, but they not know about combating environmental pollution, 15% from students know only about pollution, but they not know about combating environmental pollution and combating of pollution of honey of bees, but 5% do not answer to this issue (Fig. 2). The results analyzed has been influenced and by the fact that some of the students interviewed do not study the *Ecology and Environmental Protection* discipline, their specialization being totally different, and others studying this educational-instructional discipline to the end of the bachelor program and some students study ecology and environmental protection as optional discipline. Hence result the need to complement formal ecological education and environmental education on non-formal and informal pathways. Also, is necessary to continue and intensified the ecological education and environmental education, the education for health of food, at the same time, and for professional education of students during the next years of bachelor's and master's studies, mainly by SMART methodology, but and by practical-heuristic and interactive methodology based on investigation, projects, formal and non-formal.

Reconstruction of conceptualization of ecological and environmental education process: In her effort of reconstruction of conceptualization, the researcher has showed that in the process of ecological and environmental education are necessary 4 stages successive and interdependent, as following (Fig. 3):

The theoretical stage or cognitive stage, realized in framework of educational process of teaching and learning of ecological and environmental concepts through that the students become familiar with ecology and environment;

- The stage of awareness of the necessity of both studying ecology and maintaining the stability, balance and self-regulation of the ecosystems, protection of environment, as these ensure life continuity on Earth;
- The affective-emotional stage with an axiological purpose, it implies the development of some ecological attitudes and values to students, which will enable them to build a personal attachment to ecological systems, particularly the natural ones;
- The praxeological stage or practical stage is the stage of formation of one ecological and environmental behavior respectively the development of ecological skills and habits, of the ability to take practical ecological actions, of the will to act according to ecological guidelines; this stage represents the volitional element, which aids in the process of making favorable ecological decisions.

Jeronen *et al*. (2017), consider that the repercussions of students' own behavior must discussed and sustainable actions must practices in local environs. The environmental education is based on ecological education, being an applied branch, materialized through action, demanding a lot of practice and proficiency in basic ecological terminology, which should support practical activities.

Identification of teaching and learning methodologies and examples of formal ecological and environmental education

Formal ecological and environmental education by practical-heuristic and interactive methodologies based on investigation: The practical-heuristic and interactive methodologies allow discovering of ecological and environmental concepts by directly activities of students in ecosystem, in Nature, they working in team or group, interactive. To Biology, in *Human Ecology* chapter, can be applied this methodologies through investigation, where individual experiment is combined with team or group experiment and assess prior skills, the method giving of the students the opportunity to apply creatively the knowledge acquired in new and varied situations. Ciobanu (2008) consider that the investigation is especially useful when the students discover and explore environmental phenomena. In order to be an investigation, several experimental activities based on experiences or practical works must be designed and conducted. Any investigation requires the elaboration of assumption (s), the confirmation / refutation they're by argumentation, the enunciation of conclusion (conclusions), being applied and others interactive methods, e.g. heuristic conversation, discussion. The design of experiments is the design of any task, experimental task; that aims to describe or explain the variation of information under conditions that are specified in hypothesis to reflect the variation. An example of an investigation to *Biology* discipline, for high school students from the last year of study is also the subject: *Investigation of the ecosystem of the park* - an interdisciplinary experimental investigation based on experiments of ecology, on macroscopic observation, the biological concepts and ecological concepts being in interdisciplinary correlations with those from Chemistry, Physics etc. The focus of sustainable education is on the interaction between social and ecological systems requiring interdisciplinary thinking skills, as has showed Palmberg *et al*. (2015). The materials needed are: soil thermometer, anemometer, lux meter, pH meter or pH indicator paper, analytical balance, rain gage.

For investigation of abiotic factors-investigation of abiotic parameters of park ecosystem can be realized the more experiences and practical works as:

- Soil temperature measurement with soil thermometer;
- Soil moisture determination by successive weighing of fresh and dry soil samples, the difference being the water content of the soil;
- Soil pH determination with pH-meter or pH indicator paper if the soil sample is sufficiently damp (Fig. 4);

- Measuring wind speed with anemometer;
- Rainfall recording with rain gage;
- Measuring the intensity of light in the park with the lux meter.

For the investigation of biocoenosis (biotic factors), the practical works consist of dividing the investigated area into square parcels with the side of 1 m, after which the flora and fauna is observed, it is taxonomically determined, it is harvested for laboratory analysis, are counting the individuals of each species determined on each parcel (sample), the total number of parcels (samples), the total number of individuals belonging to all species in the divided plots, the number of individuals investigated from species other than the one expressly making the object of the research. In according with Jucker (2001), practical problem-based learning develops this kind of understanding. It is determined by mathematical calculations the frequency of one species by applying (Eq. 1):

$$Fx = px / P \bullet 100 \quad (1)$$

where:

Fx is frequency of one species, px is the number of samples in which the species were identified and counted;

P is total number of samples.

The constant (C) of one species is determined based on the frequency estimated by percentages and shows to what extent a particular species participates in the biocoenosis structure;

- if Fx > 50%, the species or population is constantly present in biocoenosis;
- if 25% < Fx < 50%, the species or population is accessory;
- if Fx < 25%, the species or population are more likely to encounter accidentally in the biocoenosis component.

The relative abundance is calculated by the following (Eq. 2):

$$Ax = nx / N \bullet 100 \quad (2)$$

where:

Ax is the relative abundance of one species;

nx is the number of individuals of an investigated species in the sample;

N is total number of of individuals belonging to the other species in the sample.

The results of the students' experiences and practical works confirm or infirm the hypotheses, giving concrete arguments. At the end of the investigation, students will draw conclusion (conclusions).

In Biology didactics, for ecological education and environmental education, as well as for other areas of education, it is necessary to respect the biological principles, mainly the *organism-environment* and *unity-diversity* principles, as well as all teaching principles on cohesion between theory and practice, the use of intuition, conscious and thorough acquisition and active learning, systematization and continuity of knowledge, awareness of age differences, focus on the individual and differentiated education.

Formal ecological education by interactive and heuristic methodologies based project method: The interactive methodologies can be realized and by projects, through which the students making directly activities of students in ecosystem and/or in ecological/biological laboratory, where they working in group or in team, interactive. The project is an action-investigation-research theme, aimed at achieving a well-defined goal, to be achieved, as far as possible, by combining the theoretical knowledge with the practical action, that can be based on individual and team experience, require students to

explore a problem or concern stated either by the teacher or the students. In some projects the students discovering of ecological and environmental concepts, the methodologies becoming such the interactive and heuristic methodologies. It is a broader activity than the investigation, starts in the classroom by defining and understanding the task, goes on at home for a few days/weeks/some months and ends in the classroom by presenting it to colleagues or a report on the results obtained and, if so, of the product made. Alesandrini and Larson (2002) have shown that students learn through participation in project-based learning where they make connections between different ideas and areas of knowledge facilitated by the teacher through coaching rather than using lectures or step-by-step guidance. An example of ecological education and environmental education project, namely *Combating the pollution!* realized by students is presented below.

Purpose: the ecological education and environmental education of people.

Objectives

- Identifying of ways of pollution, including of the soil pollution;
- Creating tools for ecological education and environmental education;
- Application of ecological education and environmental education tools.

Beneficiaries: 330 people of different ages (one group with 30 students divided in 6 teams with 5 beneficiaries directly involved in each team of students form project, and 300 beneficiaries indirectly involved).

Material resources: questionnaires, flyers, bibliography of ecological education and environmental education.

Duration: 1 semester.

Stages and activities

- The announcement of the subject, purpose and objectives by the teacher;
- The realization of composition of student's teams;
- The realization by students, coordinated by the teacher, of a work plan;
- Distributing the tasks to students from teams;
- Developing a questionnaire on how people know about pollution and combat it;
- Administration of the questionnaire by the student's teams (70 beneficiaries);
- The processing of the data from the questionnaires by the student's teams, determining whether and how the rules of pollution combating have been observed;
- The preparation by students of flyers *Rules of soil pollution combating*; an such example of flyer have the *urge Collect household waste in special containers separated in categories glass, metal, paper, plastic!*, *Cleaning the residues on soil!* (Fig. 5);
- Distribution of flyers by the student's teams in the project group (30 beneficiaries directly involved);
- Distribution of flyers by the student's teams to the student's classes belonging to the schools in which they have study (100 beneficiaries);
- Distribution of flyers by the student's teams by weekend travel in the Herăstrău Park from Bucharest to some people of different ages who have come to relax in the park (130 beneficiaries);
- The presentation of the project results in students group by the student leader designated by each team;
- The assessment of the project carried out by each team: preparation of the activity plan, elaboration of the questionnaire, elaboration of the flyer, scrutiny of the stages and of the project activities, selection and use of the bibliography, interpretation of the results obtained by administering the questionnaires, presentation of the project results and so on.

Derevenskaia (2014), consider that the application of the project method allows students to learn the ecologic and biological disciplines more effectively and profoundly, to develop practical competences, and it also contribute to increase up psychology of responsibility of students in the regional environment.

The roles of E-learning and ICT in SMART Sustainable Ecological and environmental Education to Biology: When natural conditions of environment and weather do not allow application of practical-heuristic and interactive methodologies, directly in Nature, by applying the Electronic-learning (E-learning) and ICT to Biology, it contributes to specific aspects of SMART Sustainable Education, e.g. SMART Sustainable Ecological Education and SMART Sustainable Environmental Education. In the E-learning can be applied as being the best way as teaching and learning way the CAI and the Internet, in which Virtual Reality (VR) use. Carnoy (2004) showed that the ICT is fast becoming found everywhere in the developed countries public schools and is diffusing in the developing countries education systems. In according Programme for International Student Assessment's (PISA) 2012 report, there are countries where the percentage of students using the computers at school is very good, which is very good for SMART and sustainable education, including for SMART and sustainable ecological and environmental education, e.g. Australia-93.7, Norway-91.9, New Zealand-86.4, at the opposite end, are countries where the percentage of students using the computers at school is little, which not is good aid to SMART and sustainable education, including for SMART and sustainable ecological and environmental education, e.g. Korea-41.9, Uruguay-49.9, Turkey-48.7. (Organisation for Economic Co-operation and Development, 2015). A SMART Sustainable Ecological and Environmental Education based on electronic learning by ICT contribute to sustainable development. For example, with the help of electronic means-3-dimensional (3D) printer, laptop, but also of plastic recyclable materials, students can carry out practical work making some object models, e.g. trophic pyramid, using a computer program, through practical electronic works in correlation with modeling, making transdisciplinary correlations between *Biology*, *Informatics* and *Information and Communication Technologies* disciplines. Formal Ecological Education through SMART methodologies applied in *the Terrestrial anthropisation ecosystems* learning unit, at Biology, in high school, can be achieved through E-learning ways with ICT and VR, such as *HSEA* program applications, through the computers and *Interactive Biology Lessons-Volume I* software, electronic presentations using PowerPoint slides, Digital Video Disc (DVDs), video projector, computer, electronic board, as follows (Table 1).

Are some significant limitations of the use of SMART methodologies e.g.: psychomotor objectives of biological education cannot be achieved; reduces the interrelation between pupils, between them and teachers, contributing to lower direct socialization, to dehumanization of the teaching process. Therefore, SMART methodologies based on CAI method and others methods which use ICT should be alternated with practical-heuristic and interactive methodologies, through which to apply the specific biology techniques such as investigation, experiments, macroscopic observation, microscopic observation, etc. and, at the same time, to use the specific equipment, chemicals and laboratory instruments, so that the psychomotor objectives of the biology school curricula in force can be achieved. Also, for overcome the dehumanization of the teaching process can be organizing direct, team-based sociocentric activities integrated into the e-learning lesson. Ciobanu (2009) consider that to prevent dehumanization of the didactic act (one of the significant goals of biological education) it is necessary to organize activities in teams, micro groups, pairs.

Non-formal ecological education and environmental education: The term "non-formal" (Lat. non-formalis = no official forms outside formally organized forms for a certain type of activity) means a less formal reality but always having educational consequences. Thus, young people can be involved in projects on: conducting scientific research; mapping protected areas; monitoring the protected natural habitats and wild species, which are of community interest; the reforestation and restoration of damaged ecosystems; raising awareness of the environment. The non-formal education during the excursions of students, as part of their specialized practical training in the *Biology, Ecology, Consumer Protection and Environmental Protection* profile, etc., aim to educate them to protect the environment and adopt an ecological behavior, i.e. cleaning some areas in the forests of dry branches and garbage thrown by tourists, collecting of small samples of biological material for putting them on display and taking pictures of rare law-protected species. As showed Hart and Nolan (1999), fieldwork had a positive effect on student's knowledge, attitude and behavior, crucial factors also in promoting sustainability.

Non-formal Ecological education and environmental education can also be achieved through the development of scientific research projects by students, coordinated by academic staff such as research on *Melliferous plants-bees-honey of bees-human-society correlation and its role in ecological education and environmental education of students*. The students involved from the Faculty of Food Control and Expertise and the Faculty of Food Products Engineering have realized in the present research several practical activities whereby they have developed extracurricular competence to distinguish a foodstuff, namely honey, which meets the quality standards and one polluted and / or falsified product and hence should be withdrawn from its sale to the population. Experimental data on honey obtained by students have indicated that honey of bees not is polluted, not contain microorganisms. At the same time, they have continued their ecological education in the sense of the need to respect, preserve trophic chains in nature, and nutrition correlations between melliferous plants, which must be protected, grown and bees, on the one hand, and on the other hand they carried out concrete activities to raise the awareness of the student community about the need to protect the natural environment by making and distributing flyers and leaflets with exhortations in this respect, but also in the sense of choosing a correct food product, so, environmental education and food education activities. On the occasion of Earth Day-April 22, of International Environment Day-June 5, of International Day for the Protection of the Ozone Layer - September 16, a series of activities can be designed, organized and carried out, such as:

- Greening of some parks, green spaces;
- Planting of trees, shrubs, herbaceous plants;
- Organizing symposiums on the topic of deterioration of the natural environment and the need to preserve a clean, healthy environment;
- Ecological and environmental protection contests etc.

Teachers and students can become volunteers in projects of one ecological, environmental, civic associations and foundations.

Informal ecological education and environmental education: The informal (Lat. informis, informalis = no definite forms, something happened) ecological education and environmental education refers to the totality of unintentional and diffuse information that people, especially the young population, students and pupils, are exposed to on a daily basis and which is not selected, organized and processed from a pedagogical point of view. As significant sources of environmental education and informal education are those produced by the media: television; radio; press; internet. There is a need to encourage the informal ecological education and environmental education so as to contribute to self-education, including in these aspects of education. Students must acquire documentary skills, select media sources with educational value, because some media sources are non-educational components. Through memorable, experiential, and active processes, students learn to discuss their own value selection and to evaluate phenomena and sources of information critically (Maina, 2004; McMillan *et al*., 2002).

Conclusions

The research on ecological education and environmental education shows the correlation between them, namely the ecological education is the foundation of the environmental education, but and the environmental education in its turn reinforces ecological education because only by protecting the environment can be maintain the equilibrium, stability and self-regulation of the ecosystems on Terra. For sustainable ecological and environmental education is very necessary to develop of the three types of education-formal, non-formal and informal, they complement each other. Sustainable formal ecological education and environmental education, involve numerous educational ways, by applied of practical-heuristic and interactive methodology based on directly activities of students in ecosystem, respectively on investigations done by students, in team and group, through experiments with experiences and practical works, observation, heuristic conversation, discussion, projects realized by students, in team and group. Also, has been applied and identified as better didactical way, the SMART methodology with of aid ICT and of numerous modern methods, e.g. CAI through *HSEA* applications, multi-media demonstration, and their observation, practical electronic works correlated to modeling of some object models with aid of computers network, the computer programs, software, video projector, SMART board, 3D

printer, what is constituted in SMART methodology, through which can be realized SMART Sustainable Ecological and Environmental Education. These methodologies identified, respectively the practical-heuristic and interactive methodology and SMART methodology brings one cognitive and affective plus, contributing to sustainability of ecological and environmental education, to sustainable and SMART education. All this outcomes have been demonstrated by results of assessment tests, which have increased from initial test to current tests and final test. In teaching of Biological Sciences is very necessary the effective use of informational content in the ecological education and environmental education, that must be fully exploited, in the process of ecological and environmental education being necessary 4 stages successive and interdependent, respectively the cognitive stage, the stage of awareness, the affective-emotional stage, the praxeological stage, in which to respect the biological and teaching principles.

The projects can be very good education ways, both formal and non-formal education. Done outside of the courses, seminars, laboratory works, lessons, curriculum, non-formal ecological and environmental education complements the formal education of students by participating in research projects, ecological and environmental education projects and campaigns, as volunteers of one ecological and civic associations and foundations, environmental actions, creation and distribution of flyers with ecological exhortations and environmental education messages etc. So, for a sustainable ecological and environmental education in Biological Sciences, must develop, alternation and completion of the 3 forms of education, formal, non-formal and informal, develop, alternation and completion of application of some practical-heuristic and interactive methodology, practiced mainly in Nature, but and SMART methodology, when natural conditions of environment and weather do not allow otherwise, being necessary multiple correlations, with to respect the biological and teaching principles.

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