October 2013, Vol. 7, No. 10, pp. 1113-1122
Journal of Life Sciences, ISSN 1934-7391, USA

Development of School Methodology for Field Study of a Botanical Pineland

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Received: October 16, 2012 / Accepted: December 21, 2012 / Published: October 30, 2013.

Abstract: The major importance of forests is critical to the survival on planet Earth. Forests are threatened by a lot of dangers and all of us have to contribute to the fight for their survival. The methodology of school research on pine woods which is described below, aims to cultivate more sensitive, educated and activated students, by accordingly specialized teachers who are going to organize the educational background, also to decide techniques and materials for the easiest and most effective learning, for the cultivation of values, attitudes and friendly behaviors towards forests. The suggested methodology is based on the findings of a European Comenius Program and two Programs of Environmental Education. The research usually takes place in a pine land, by using a worksheet as experimental tool, and focuses on the vitality of the trees, the biodiversity, the effects of pollution and other cultural elements related to the pine bio-community. There is also a lot of informative discussion and research over cultural, social and economical factors with locals and specialists.

Key words: Pineland, bio-community, field research, school teaching.

1. Introduction

The importance of forests is enormous and critical to our survival on Earth. The dangers that threaten them are many and require the contribution of us all in the fight to rescue them. Greece is the poorest country in Europe in forest cover due to the bad management of the past. The forests, extending from the sea level to 1,900 m height, are bio-communities with a wide variety of plants and animals. The trees of the canopy (top layer) are pine, cypress, fir, oak, chestnut, beech, elm, poplar. Cultivated trees are citrus fruits, olives, bananas [1]. The sub-canopy consists of brushwood shrubs, bushes, heather, ladanies, skina, sedges, ferns, ivy, moss, lichen. The protection of forests from fires, logging, farming, agriculture and building should be the first concern of every healthy society along with the protection from their natural enemies. Alternative tourism and agro-tourism can give breath to the rural areas, as Greece has significant requirements for this type of development, such as the great variety of scenery, good weather, sense of the virgin, the history and tradition that is a unique value for the nature lovers. Students need to get to know the forests on the spot and not only through books and documentaries, in order to be aware, and be prepared to undertake action, by appropriately trained teachers, who will organize the educational environment and choose methods, techniques and materials for the most convenient and effective learning. Jerom Bruner [2] believes that in the dialogue about the education a minor meaning and importance to the deeper nature of teaching and school learning has been given, neglecting the means that a teacher utilizes to teach and the students have developed to learn. A detailed scientific study may easily and enjoyably prompt students to love and protect forest in the future, contributing to the overall planning and strategy of their schools and local community on the protection of the forest wealth [3]. According to a holistic

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investigation within target levels, students, at the level of ecological foundation, will become acquainted with the forest ecosystems, key ecological concepts and terms, the interconnections and interactions between biotic and abiotic factors [4].

At the level of ecological consciousness, students will realize the contribution of forests to the life and economy of the local communities, the value of the equilibrium and the consequences of their disorders (reduction of biodiversity, climate change, degradation of land, displacement of people, loss of jobs and economic resources, reduction of the natural resources in general). At the level of life skills, in addition to the cultivation of their general education, skills of observation, formulation of hypotheses, searching for alternative solutions, data interpretation, communication, collaboration and participation in jointed activities will be developed. For the emotional and psychomotor development, the students will experience the value of a collaborative team spirit based on equality, understanding, mutual support and open communication. They will also come closer and work with other students, teachers and institutions, enjoying innovative pedagogical methods and procedures significantly different from the usual traditional that are followed at the school curriculum [5].

Below, a methodology of School Teaching Research of a pine-forest plant community is presented, based on the findings of the European Program Socrates/Comenius *European Forests Network* which was materialized by the Lyceum of Soroni Rhodes in the period 1996-1999 in collaboration with schools of Italy, Germany, Ireland and Sweden and on the Environmental Education Programs The Forest of the Epanosifis Monastry and The Forest of our Schoolyard, that were materialized by the Lyceum of Meleses during the school years 2000-2003 and 2009-2010. This is carried out in the context of the Greek Pedagogic Institute on teaching about forests [6] following the guidelines of the Greek Ministry of Education [3] on the design and implementation of the school Environmental Programs, leveraging ideas from the educational programs and networks that apply the Greek Centres for Environmental Education, in a comprehensive overview. The particular reference on the pine forests is dew to the studied pinewoods, common on the Mediterranean islands.

2. Materials and Methods

The field study is based on innovative educational methods and techniques concentrated on the Methodology of Projects [7]. Students are being motivated to discover by themselves the new knowledge and solve complex local environmental problems, with teachers' monitoring and guiding [8]. The students have to work as scientists exploring nature. They work alone or in groups on approaching the subject in a multi-faced way, to collect data, to formulate it and draw conclusions which can be publicized to the school and local community [8, 9]. The teacher avoids intervene, only if it is necessary. The guided discovery is a constructive teaching strategy because students involved in this process, develop and restructure their knowledge and conceptual patterns through the gained experience and the exploratory discussion, supported by the teachers [10]. Team work helps them to tolerate and respect the others' opinions and attitudes and to form an integral part of the procedure of their socialization [5]. It is necessary, all the participators in this study to concentrate, apply and spread the acquired knowledge, focusing on biodiversity, which is linked both to the study of the ecosystem and to the impact of human societies on its maintenance, according to the analysis of school textbooks in a various description of biodiversity [11, 12].

The frequency of visits to the forest depends on the school planning, but visits during different seasons give the possibility of noticing and recording the changes of the nature during the year. All the

observations and measurements are recorded on a worksheet, individually for each tree. The worksheet contains questions concerning the weather, the soil, the animals seen either in transit or hidden among plants or into the soil, the trees, the woody, herbaceous and flowering plants, weeds and floor covering, the human activities, cultural features etc. [6, 13-15]. Emphasis is given to the particular characteristics of the dominant species and to the differences among the *Pinus* species such as *Pinus brutia*, *Pinus halepensi*s, *Pinus nigra*, etc. [14]. The statistical analysis accompanied with the discussion of results of similar researches, leads to conclusions for the type of forest, the density and synthesis of the botanical community, in what condition the pine forest is, etc.. The results can be presented by maps which illustrate the diversity regions or be uploaded at the school website or specific data bases. The interdisciplinary approach of the studied object is achieved through courses of history, literature, biology, chemistry, physics, ICTs, technology, music, theater, folklore, also through the collaboration of different specialty teachers, scientists, organizations and authorities. Questionnaires, concept maps, interviews from experts and locals, laboratory experiments, field observations and measurements, drama, scenarios can be the educational techniques for the students' acquaintance and awareness [6]. Educational scenarios, based on the synthesis of the collected material and information, can be developed on the protection of the forest from fires and the economic future management of the forest.

Environmental research differs from most formal curricula of Science in Secondary Education because of its emphasis on the sociological nature of science [16].

Below is the tool of pineland research, a worksheet for field work, a guide for the students before, during and after the visit to the pineland. In an added column on the right of the table, students write observations and measurements, as shown in Table 1.

Table 1 Tool for pineland school research.

I	Before the visit to the pineland (at School)	
A	Decision on the methodology (interdisciplinary approach)	
1	Connections to the curriculum	Courses of history, literature, biology, chemistry, physics, ICTs, technology, music, theater, folklore, etc.
2	Collaboration with	Different specialty teachers, scientists, organizations and authorities
3	Selection of Innovative educational techniques	Questionnaires, concept maps, interviews from experts and locals, laboratory experiments, field observations and measurements, drama, scenarios, games
4	Frame of the team work	Coordinators, roles and the ways of communication
B	Discovering the subject matter	
1	Inquiry in libraries, internet, and archival material of Media	About the life in/close a forest, threats, usefulness, consequences and results from the destruction of forests
2	Clarification of key environmental terms of biotic and non-biotic factors of a forest ecosystem	Flora, endemic plants, spontaneous plants, fauna, food chains, soil, water, weather etc.
3	Discussions on the forests' value	In the confrontation of climate changes, global warming, pollution and halting the decline of biodiversity
		In the life of local community in the past and present
4	Selection of the study area	Describe the close around
		Set up the boundaries, calculate the slope, the dimensions, the altitude, the distance from the main road on a Google map
		Hills, mountains, roads, rivers, lakes, farmlands, villages, towns, cities, houses, churches, cemeteries, hospitals, industries, sheepfolds, disturbing units etc of the vicinity of the pineland plan how to access the study area.
5	Investigation of the existing rights and ownership of the forest	Along with the local social and economic management and development with emphasis on the protective legal status
6	Collection of cultural features	Literature, songs, myths, stories, traditional and historical elements

Table 1 continued

II	Visit to the pineland	
A	Weather conditions during the day of visit and the day before	
1	Atmospheric phenomenon	Atmospheric fallout, fog, clouds, humidity, winds speed
2	Signs taken into account for the weather forecasting	Signs in the behaviour of animals for upcoming good or bad weather, observations to shape, height, colour and movement of clouds, barometer indications, the direction and intensity of wind, visibility and humidity of the air
B	Soil observations and sampling	
1	Different soil types concerning the composition and properties	Sandy, clay, humus, mixed etc
2	Features	Color, rocks, fallen needles
3	Possible types of erosion that may have occurred during the creation of the territory of the studied forest (discussion on hypothesis)	Physical, chemical, biological
4	Escavation and soil sampling	Samples for chemical analysis
C	Plant community	
1	Species of the canopy trees	Identification by key usage(Latin or/and Local names)
2	Species of sub-canopy trees and plants	Identification by key usage (Latin or/and Local names)
3	Age of the canopy trees	Average
4	Observations of the trees	The tree belongs to the species
		Position/class standing alone, in cluster, dominating, tallest, repressed
		Slope caused by the wind
		Trunk damages
		Broken branches
		Type of foliage (needle) loss (bottomless, edgeless, topless, middle, window, otherwise)
		Discoloration of the needles
		Tree grazing
		Vitality of the tree top
		Presence of cones (a few, many)
		Clinging plants, fungi, mosses and lichens on the trunk
		Attack of noxious insects/caterpillar co-coons
		Resin outflow
5	Measurements of the trees	Tree height (m)
		Trunk perimeter (cm)
		Central branch stem length (cm)
		Percentage of lost tree needles (approximately)
		Needle length (cm)
6	Specific characteristics of the dominant species	Tree form (pyramidal, spherical)
		Needles sprout (singleton, in pairs)
		Needles (smooth, rough on one side, rough)
		Needle color (dark, light)
		Needle cross section (semicircular, triangular)
		Cones outgrowth (stem-less, short stem, vertically to the branch)
D	Animals seen	
1	Positions of animals seen	Passing, on the ground, in the air, on the trees and plants, hidden among plants, hidden into the soil
2	Description of the interaction of animals-plants	Grazing, shelter, crawling, none
E	Feel the forest through the senses	
1	Vision	Colors, shapes, natural creations

Table 1 continued

2	Hearing	Noises, sound, silence
3	Touch	Leaves, branches, flowers, plants
4	Smell	Leaves, flowers, plants
5	Balance	Walk on the rocks, trees, wood logs
F	Human activity	
1	Human interventions in the vicinity of the study area	Roads, fields of grazing, farmland, industries/crafts, churches, cemetery, houses, schools, hospital, dam, electricity network, water network, public service, disturbing units, other
2	Pollution hot spots	Pesticides, litter, debris, smog, else
III	After the visit to the pineland (at school)	
A	Laboratory work	
1	Chemical analysis	Of the soil samples
2	Microscopy	Microscopic and stereoscopic observation of collecting material by using specialized software (Statistical Package)
B	Statistical analysis of quantitative data	
1	Conclusions on the	Type of forest (coniferous, mixed, dense-sparse, deciduous, etc)
		Density and synthesis of the botanical community
C	Synthesis of the results	
1	Energy flow	Design of trophy pyramid, food/energy chains and webs
2	Estimation of forest condition	Correlation of human activity with tree condition and recorded biodiversity
D	Dissemination	
1	Results illustrated on maps	Map containing information of the study area: boundaries, slope, orientation, dimensions, altitude, the distance from the main road
		Map of hills, mountains, roads, rivers, lakes, farmlands, villages, towns, cities, houses, churches, cemeteries, hospitals, industries, sheepfolds, disturbing units etc of the vicinity of the study area
		Maps of the biodiversity of the study area
		Maps of pollution hot spots (pesticides, garbage, debris, else)
2	Publications	Upload the collected material at the school website or specific data bases
		Publications in printed or digital form (guides, reports, albums, else)
3	Social activity	Open events in the school and local community
		Formulation proposals for the future management and exploitation of the forest in the frame of the sustainable development and the Local Agenda to local authorities and government
		Tree planting in burned areas
		Campaign for forest rescue

3. Results and Discussion

The protection of forest wealth is social priority of great importance which requires informing, knowledge, updating, awareness and activation of the society [1]. In local level, priority for each municipal authority and strategic goal for all schools are to raise awareness of youth in contemporary environmental issues, to undertake initiatives and actions to solve them, for the environmental and cultural upgrading of their place. According to Francis Bacon, the aim of Science is to improve the people's destiny by collecting events via systemic observation and the extraction of theories from them [17]. The program "Investigating & Evaluating Environmental Issues & Actions", [18] reports that since students have a potent interest in the natural environment, helping them to make independent research on environmental issues and take action then as responsible citizens, they can achieve effective environmental knowledge. The

students, by learning and applying the methodology of biological science, progressively learn how to face the real life situations because the life is, actually, experimentation, a survey [19].

3.1 Executive Investigation of the Subject before the First Visit to the Pineland

In the beginning, students and teachers discuss about the subject, the research methodology, the frame of the team work, the roles and the ways of communication. Students search in libraries, internet and archival material of media about the life in/close a forest, threats, usefulness, consequences and results from the destruction of forests [6]. Teachers clarify key environmental terms of biotic and non-biotic factors of a forest ecosystem, particularly flora, endemic plants, spontaneous plants, fauna, food chains, soil, weather, et al. and introduce the students to the experimental research [14, 15]. The soil is dealt as support instrument and plant nutrition, as living space of large number of animal species. In a wider acquaintance with the multi-factorial subject of forest study, discussions are developed on the contribution of forests in the confrontation of climate changes, global warming, pollution and halting the decline of biodiversity. Also, is inquired the value of the forest for the life of local community in the past and present. Concluding the results, students formulate proposals for the future management and exploitation of the forest in the frame of the sustainable development and the Local Agenda.

After this, chosen the study area of the pineland and describe the close around. By using the Google Earth Map, the students work in teams, set up the boundaries, calculate the slope, the dimensions, the altitude, the distance from the main road and they plan how to access it. Hills, mountains, roads, rivers, lakes, farmlands, villages, towns, cities, houses, churches, cemeteries, hospitals, industries, sheepfolds, disturbing units etc of the vicinity of the study area are noted, also. Progressively a map is built up containing all the related information. The existing rights and ownership of the forest are investigated along with the local social and economic development in connection with the forest with emphasis on the protective legal status. A collection of local literature, songs, myths, stories, traditional and historical elements concerning the forest unravel the thread, connecting the past with the present.

Data about weather of the day of visit to the pineland area is recorded, regarding the atmospheric fallout, fog, clouds, humidity, winds speed [13-15]. Searched signs in the behaviour of animals for upcoming good or bad weather and take into account various data for the weather forecasting, such as observations to shape, height, colour and movement of clouds, the barometer indications, the direction and intensity of wind, visibility and humidity of the air [15, 20].

3.2 Field Work at the Pineland

During the first visit, students bound the study area and give numbers to the trees, facilitating the following visits, monitoring each tree individually or in total. They can also put a label which informs that this section is part of a forest school study. They practice in the orientation by using compass and recognition of signs of ecological sequence and forest regeneration.

Recognizing different soil types (e.g., sandy, clay, humus and mixed), the composition and properties, discussed the possible types of erosion (physical, chemical, biological) that may have occurred during the creation of the territory of the studied forest [21]. Students excavate and take samples of the soil from different sites to make chemical analysis in the school laboratory.

The measuring of the height of the trees proposed to be done by an approach based on the proportions of the sides of similar triangles, by two students who use a meter and a stripe. A student puts the strip parallel to the tree in front of his face in appropriate distance in order to the strip to be able to cover the entire tree

height and then rotates it 90 degrees. Another student starts to walk from the tree, perpendicularly to the straight jointing the first student with the tree until to coincide with the second edge of the strip, the first is on the base of the tree. The distance between the two students is the height of the tree [14].

The annual growth of the trees can be calculated by measuring the trunk circumference, by using a plastic meter, or by the length of the central stem of a tree branch. The first way needs some years mediate for any noticeable change, while the edge part of a branch corresponds to the recent growing period [21]. Growth measurements which have been materialized for many years can lead to conclusions on the age structure and growth of the forest.

The age of the trees can be calculated by the growth rings of some dead or cut down trees. The mode and the shape of deposition tell the story of each tree. Their density shows the rapid or slow growth of the tree due to favorable or non-environmental conditions during the previous years. The transverse cracks are indication of large frost. A small carrot from the periphery towards the centre of the trunk can also be excavated, with a special tool which does not cause significant damage to the tree [22].

Studying the special characteristics of the dominating species within pineland, students make observations relating to the height and shape of the trees, the truck thickness, the type of needles, the resin outflow, the sprout, length, color, cross section of needles, the cones outgrowth, et al. [13, 14].

As for the constitution of the botanical community (flora) regarding the trees of canopy and the trees and plants of sub-canopy, students seek the local and/or Latin name and classify them as deciduous, evergreen, annuals and perennial, woody plants which are shrubs and saplings, herbaceous plants which are grasses, grains and small flowering plants, weeds. Their trunks and stems can characterized as juicy, fleshy, smooth, rough, and their leaves as wide, narrow, toothed, oval, palmate, oblong, etc. [15]. The floor covering made up of the fallen leaves, stems, mosses and lichens, etc..

As for the fauna, animals seen either in transit (e.g., insects, birds and hares), hidden among plants (e.g., snakes, lizards and spiders) or into the soil (e.g., worms, arthropods and mice), some of them noticed by magnifying glasses, are recorded and recognized by using niche keys. Students emphasise on the type of mobility and interaction of animals and plants, for example passing or crawling on the ground or plants, flying in the air, jumping on the trees and plants, hidden among plants, hidden into the soil, shelter, grazing, etc..

In a synthesis of the forest bio-community, students put the identified organizations in energy pyramid, in food and energy chains and nets, not ignoring the saprophytes and decomposers that feed on dead organic material and developing discussion on the energy flow, the biogeochemical cycles, the trophy relations, the causes and consequences of possible fluctuations of the referred populations.

Students, also, look for indications and elements of human interventions, such as housing development, grazing, farming, opening of roads, logging, pollution coming from pesticides, garbage, debris or other signs of soil degradation, giving explanations of the causes and the needs dictated them [15].

In order to assess the tree and forest condition, are checked the thinning of the crown/defoliation, the type of needle loss, the crown vitality, the tree discoloration, the presence of fungi, the clinging of plants, mosses and lichens, caterpillar co-coons, air pollution affection, natural or stress of human activity, etc. [13, 21].

During the visits to the forest, students try to realize, to feel the forest through their senses by concentrating elements which reveal and highlight the colors of each season, staying alone concentrated to themselves and eavesdropping of the sounds, feeling the silence, touching and smelling of leaves, broken branches, flowers, plants, collecting material for works of arts or for observation under the microscope and

stereoscope [14, 23]. Experiential games and various innovative teaching techniques can be applied inside the forest or the classrooms acting additively to the scientific field work [21].

3.3 Actions and Interventions

After detailed observations, records and discussions about the forest habitats, capitalizing the research results, the students can establish an environmental pathway for the visitors of the pineland, consisting of special signing and publish a guidebook, containing geological, ecological, historical, cultural information about the forest, maps and special guidelines. Wooden labels placed on signs at issue can prevent hunting and disturbance, drawing the attention and sensitivity of the visitors to the protection of the forest communities. Students can also give concerts, to organize photo and visual artistic exhibitions, speeches, round tables, contributing in the better awareness, management and caring of the forest by the locals, with emphasis in fires and hunting. In consultation with the local forestry, they can plan tree planting for burned areas or enrich others. Also, students can attend letters to government and organizations for the management and protection of the forest, in collaboration with their parents' union, local authorities, NGO, et al. and start a campaign for the forests rescue.

3.4 Evaluation

The proposed framework of the design and implementation of a school field study of pine forests promotes much improvisation and self-motivation in the educational process to sensitize initially hesitant and uninvolved students and work together with enthusiasm, joy and pleasure, yielding the maximum. This allows continuous, formative assessment, with the possibility of feedback in the developing programs. The final evaluation is accomplished by synthesis and discussion of the results, methods, processes and materials which can be presented at educational conferences and discussions. The evaluation of the educational process can be done by observing how students work or by answering some short questions which were attended to the students. The program's evaluation can be carried out by a committee established with the participation of the school teachers' association, local municipality, the association of parents and students or by questionnaires and discussions in the teams in a formative or final evaluation [6, 15, 24].

The study of a forest area, from the prism of the organization of the plant and zoo community, the factors that affect them, the impact of human interventions on their balance can be modified in order to correspond to each age knowledge base, occupations and pursuits. Choosing forest area near the school facilitates the access to the sites of study offering the opportunity of frequent and extended visits, reducing costs and organizational difficulties. The development of the projects gives emphasis on the research dimension of the acquisition of the knowledge and exercise students to the scientific method by introducing them to the scientific mindset. They are practicing on observation, experimentation, analysis and synthesis of opinions, data and results, improving the skills of communication, collaboration and partnerships.

4. Conclusion

As a growing number of decisions depends on the developments in Science and Technology, in order for the citizens of the future democratic societies to be able to decide as thoroughly as possible, they should receive the best scientific and technological knowledge, without being appropriate specialists. This is a challenge for the Science Education and Environmental Education and for the Sustainable Development, to provide the framework for the development of these skills and competences. Experiential learning is proposed in the place of traditional teaching because it provides students with opportunities to experience issues and investigate

phenomena, affecting the deeper understanding of the concepts and the laws that define them and their appreciation to values, feelings and attitudes towards the nature [25].

The children have an innate curiosity about the nature and the world around which is stifled by the traditional teaching, causing negative effect on their positive attitude towards Natural Sciences [26]. By teaching with inquiry, students explore ideas and perceptions about various environmental concepts and they can achieve conceptual change with the implementation of systemic practice and the use of innovative teaching techniques [27]. The proposed Tool of Pineland Research, which was drawn to meet the requirements of the students-researchers, contains appropriate field exercises for the study of a forest plant community and can be supported by schools in terms of knowledge and materials, completing the teaching of courses such as geography, biology, chemistry, physics and mathematics, in the frame of the School Curriculum and the Projects of Environmental Education. The research is being developed into the school nearby forest area focusing on the vitality of trees, biodiversity, the particular characteristics of the dominant species, the implications of the pollution and other cultural elements associated with the forest. The exercises of the worksheets have been designed to connect with axes on community, environment, economy, introducing education for the sustainable development [28, 29]. As Mahatma Gandhi said, “an ounce of action is more worth than a ton of teaching. The books offer the knowledge, but the action translates it into understanding.”

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