DISCOVERY TEACHING IN A SCHOOL PROJECT OF EDUCATION FOR THE
SUSTAINABLE DEVELOPMENT: AN EVALUATION CASE STUDY

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CASE STUDY

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ABSTRACT

In socio-cultural theories, learning has social nature and the learner has social motives. The effective learning environment is the product of interaction between the specific characteristics of the individual and the existing opportunities for experience that can provide the objective surroundings.

Objective of this research was the Discovery Teaching Method applying process (DTM) in a School Project of Environmental Education (SPEE), the analysis of the levels and steps of the educational procedure, in order to be assessed the efficiency of promoting the principles of Environmental Education (EE) and Education for the Sustainable Development (ESD). To answer the main research question, whether in the project, as designed and implemented, applied DTM to promote the principles of EE towards the ESD, had to make a general assessment with content analysis of the project's archival material triangulating with structured interviews of teachers.

The project "Forest, Biodiversity and Quality of Life" which designed to meet the principles of EE and ESD with many and varied activities inside and outside the classroom, with local communities, in the protection and exploitation of natural environments. With the use of DTM, students encouraged to active experiential learning, in collaboration with local communities, authorities, citizens, bodies and experts.

Teachers sought experiential approach, opening the school to society, group work in the field and in society, exploited social environments, linked with natural and technical ecosystems, in an interdisciplinary and multidisciplinary approach of topical issues of the school curriculum. The project subject, agro tourism, itself, is directly related to the Economic and Management courses and Administration Business taught in Lyceums. Protection programs and interesting management practices of natural environments and traditional settlements entered under the microscope of the small researchers, maybe future entrepreneurs, making praxis the school theory.

INTRODUCTION

In socio-cultural theories, learning has social nature and the learner has social motives (Doise&Mugny, 1984; Mokias, 2008). The effective learning environment is the product of interaction between the specific characteristics of the individual and the existing opportunities for experience that can provide the objective surroundings (Birch &Gussow, 1970 in Vygotsky, 1997).

Teaching in teams is a component of all modern teaching interventions (Baudrit, 2007). Participatory approaches have proved very useful in the development of educational programs in new subject areas and in cooperation with teachers in a wide variety of topics, each with a unique task and audience (Krasny& Lee, 2002). Team learning promotes socialization of the learners and democratization of the society, providing experiential learning conditions (Kamarinou, 2000; Matsagouras, 2000). That is why, contrary to the traditional view, which considers that the information content of teaching is the important in education, in teaching in teams is equally, if not more important, the process by which the knowledge acquired (Matsagouras, 2000).

In discovery learning, the teacher decides what issues are relevant to the student's needs and the strategies that are most appropriate for the collection and analysis of the data relating to the solving problem (Victor &Kellough, 2003). The students

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follow the teacher's instructions, to meet the correct principles and relationships between variables. In inquiry learning, the students themselves define the problems related to their interests and needs, determine the methodology to be followed in the collection and analysis of data and are the ones that determine the acceptable solutions to the problems (Victor &Kellough, 2003). In structured inquiry, the problem, the process and the materials provided by the teacher, who plays the role of mediator in learning and does not inform the students about the expected results.

The discovery learning processes are difficult in their implementation, however challenge to those teachers seeking more effective teaching methods, shifting from the traditional educational approaches to more participatory and discovery, more student-oriented. Also, the enthusiasm of students to educational projects based on Discovery Teaching Methods (DTM) is not given. Students have become familiar with learning only what is required for the exams may have difficulty in a projects that does not seek one and only correct answer, which indeed holder is not the teacher, but must themselves to discover.

Environmental Education (EE) and Education for the Sustainable Development (ESD) are learner-centered types of education, using a wide variety of innovative methods and techniques in schools of Primary and Secondary Education, mainly carrying out by projects. School Projects of Environmental Education (SPEE) focus on the study of an environmental issue, mainly of local range, usually problem, which is inquired by cross-curricular and interdisciplinary approach (Chrysafidis, 2006; Raptis, 2000; Zygouri, 2006). In Greece, during last years, is attempted a widening of the schools' communication by developing partnerships with local authorities and institutions, involving parents and specialists in the educational procedure. As students of the Lyceums are close to the adult citizenship, SPEEs ought to cultivate them to be environmental, active and participative literate citizens (UNECE, 2005).

This paper studies the application of the DTM in a SPEE that implemented in Meleses Lyceum of Crete (Greece) under the title of "Forest, Biodiversity and Quality of Life" in spring of 2008, funded by the Program of Open Classes Callisto of the Greek Ministry of Education and evaluated to be uploaded to the Program website (Callisto, 2008). The project materialized by 36 students guided by 3 teachers with specialties of Biology, Computing and Greek Literature, with many and varied activities inside and outside the classroom, with local communities, with the target of the protection and exploitation of natural environments.

Teachers designed the educational procedure in order to encourage students to active experiential learning, in collaboration with local communities, authorities, citizens, bodies and experts, to meet the principles of EE and ESD, in accordance with the Declaration of Tbilisi in 1977, the UNESCO Decade of Education for the Sustainable Development (ESD) (2005-2014) and the Education Strategy for Sustainable Development as formulated in Vilnius in 2005

(UNECE, 2005). Emphasis was given on the rural tourism and sustainable management of natural ecosystems, the revival of the traditional lifestyle and anti-consumerist model. The educational design exploited the local societies, in connection with natural and artificial ecosystems, with interdisciplinary and cross-curriculum approach of issues taught in Lyceums, by the use of a variety of innovative teaching techniques.

Objective of this research was the process of the implementation of Discovery Teaching Method (DTM) in a school environmental program (SPEE), the description of the levels and steps of the educational procedure, in order to be as efficient as possible, through the prism of ESD. To answer the main research question, whether the project, as designed and implemented, applied DTM to promote the principles of EE towards ESD, had to make a general assessment, with content analysis of the project's archival material. The study focused on the process of DTM application in the SPEE, with 5 sub-queries referred to the type of DTM the levels of the activities, the educational strategy, the didactic approach and the evaluation-reflection of the project.

METHOD

The research is a qualitative research, case study with content analysis of the archival material of the SPEE, accompanied with structured interviews (Cohen &Manion, 1994; Bell, 1997). Sources of data were the Application Form (AF) of the project, which submitted in March of 2008, in digital form, and approved for funding from the Greek Ministry of Education, under the Program "Environmental Classes Callisto", the Final Report (FR), in mixed printed and digital form, and three structured interviews of the teachers who guided the project. The addressed questions to the teachers were about the project's subjects, the way that structured and implemented, the assessment and the reciprocation to the school and local community. They addressed accordingly to teachers' specialty, different for each teacher, in order to illuminate as much as possible the study areas. The archival material examined in a structured way, which sought specific categories of data, by content analysis, and more specifically discourse analysis, to meet the criteria of the Evaluation Tool for the application of the discovery teaching method in the Greek school environmental programs (Kalathaki, 2015).

The research question was stated if the studied SPEE designed and applied in accordance to the principles of DTM and EE, in order to educate students in SD. The data, which drawn by the examination of archival material and the interviews, were coded into five categories corresponding to the research sub-queries concerns the type of DTM, the educational strategy, the didactic approach, the levels of educational actions, the evaluation and reflection of the project. In the research, the word, the phrase and the paragraph were used as a recording unit (Iosifidis, 2003; Kyriazis, 1999; Iosifides&Spyridakis, 2006).

In the organization of the research categories took into consideration the issues of the project, the purpose and the applied methodology, so the key research question and sub-

queries to be in the spirit of the international problematic and practice for the EE and ESD. The prism, through data was deemed, is associated with the social and critical nature of EE, the opening of schools to the society, the cultivation of the environmentally literate future citizen who will be active in the environment caring.

RESULTS AND DISCUSSION

Teaching in teams constitutes a framework that provides background for experiential learning, enhances the expression of different views and develops skills of discussion and negotiation, strengthen the feeling of "belonging". Minimizes the competitive trends, makes feedback and communication more realistic in teams, since all the members realize that all together are benefited by the participation in the team and working together to the outcomes production (Rogers, 1998; Rutherford &Ahlgren, 1991).

Exploring the dimensions of development, seen through the perspective of SD, with structured and non- structured research, students introduced to scientific research, to didactic research of biological and social processes which, until now, had gone unnoticed in the natural and social environment they lived. The involvement of students in planning and structuring the project, and the joint selection of objectives, seem to have secured, from the beginning, their active participation. The social environment, in connection with natural and artificial ecosystems, utilized in a multidisciplinary approach of topical issues, in connection with modules of the lyceum curriculum.

Type of Discovery Teaching Method (DTM)

The criteria of the Evaluation Tool for the application of the DTM in SPEEs, regarding the following process, that took into consideration in this study, concerns the inquiry and guided discovery as didactic research educational methodology (Kalathaki, 2015). The child builds every day and spontaneous concepts of the life, from the very early, with the help, and always in relation with the social environment, which later turned into a new, particularly cognitive relationship with the world (Vygotsky, 1997; Vosniadou, 2002). In this process, the concepts are transformed and change in structure (Posner *et al.*, 1982). Vygotsky believes that there is no knowledge without social life, that higher mental functions originate from social life and that is not enough the interaction with the natural environment, but also required the social one, in the learning process.

In the DTM implementation, students determine the topics that they worked, on the basis of their interests and needs, wandering in the fields of information, knowledge and experience. "Throughout the project attempted to be especially limited guidance from teachers and enhance cooperation with more capable peers" (Teacher E1). In the AF is mentioned that the implementation method was the method of Project (Frey, 2005), where students themselves defined the problem, the methodology, chose the acceptable solutions.

The teachers were a facilitator of learning, who helped the students in formulating the problems and proposing the

solutions (Athanasiou, 2007). "During the investigation of the issue, the students raised questions and then worked for the answers, as organized they were able" (Teacher 1). The student-centered DTM promotes self-directed organization and structuring of the educational content and procedure, the selection decision and the learning ways, generally the use of the experiences of the students (D'Avanzo& McNeal, 1997 Trautmann *et al*, 2004; Victor &Kellough, 2003). "We left the students to think about what to do, following any ways they could accomplish what they wanted, in each case" (Teacher E1).

DTM is the art of creating situations in which students undertake the role of scientists, by involving in research, in order to satisfy their curiosity (Driver *et al*, 2000). "Students took their own initiative to come into contact with individuals and social groups to look for the features and benefits of agricultural development and management of natural ecosystems in Crete, comparing to the Prespes and Kastoria» (Teacher 1)."Students exercised to formulate questions, collect and analyze data, to give personal explanations and answers to issues that could not be studied in the classroom" (Teacher E2). "Students talked with locals about how they feel their far away lives, by living traditionally and waiting for development, given the fact that the students live in a faraway place, in the south part of Greece, but in a more modern way with maintains of traditional elements" (Teacher 2).

Educational Strategy

Team and solitary work in PCs and libraries, inside and outside the classrooms, are the educational strategies that followed in the project which enhanced the student-centered philosophy, facilitated student participation and promoted collaborative, team-centered, active, exploratory, laboratory and experiential learning.

The student-centered philosophy of projects of ESD (ESDPs) facilitates the participation in student-centered and discovery teaching. Since the team-cooperation learning aims to make students able to handle disagreement and complexity, the sophistication of life, division of roles and assignment of responsibilities (Breiting *et al*, 2005), DTM considered necessary from the beginning of the project. Social content objectives, which were discussed together with the students, are mentioned in the AF "cultivating team spirit to students and the experience of the value of cooperation opens communication and mutual aid ... Development discipline requirements of the program and the group".

As Tobin (1993) argues, learning is apprenticeship, ie integration in the team with assigning roles and responsibilities, collective action, seeking solutions which is guided and encouraged by the teacher who mediates between the scientific community and the students' community. "In the beginning, the students were divided into groups, based on their interests and places of residence, were allocated the tasks, roles and responsibilities" (Teacher E1). "The journalistic team undertook the interviews with the local authority and the elders in village cafes. The artistic team undertook the photographing and recording of forest Epanosifi.

The folklore group assumed the collection of legends and traditions. The ambulatory team visited gorges of the region and took over the drawing of the footpath in Astritsi gorge. The theater group through the knowledge, impressions, feelings refluxed by prearranged activities undertook to create a scene and a story to highlight them theatrically" (FR).

Didactic Approach

ESD is characterized as interdisciplinary and holistic as it is based on correlations search, multiple influences and interactions of the learner, the educators and the learning environment (Maingain&Dufour, 2002; Breiting *et al*, 2005; Scoullos, 2007). The criteria of the Evaluation Tool for the application of the DTM in SPEEs, regarding the Following Process, that taken into consideration in the research, were the Interdisciplinary/multidisciplinary approach, the connections to the curriculum and the approach of critical pedagogy for the examination of real life situations (Kalathaki, 2015). "The subject of the project is appropriate for an interdisciplinary approach, as well as PI (2007) proposes an analog one in the indicative work plan "Forest-Environment-Development". Teachers sought experiential approach, opening the school to society, group work in the field and in society, exploited social environments, linked with natural and technical ecosystems, in an interdisciplinary and multidisciplinary approach of topical issues of the school curriculum. "The project is developed on two levels, at the level of the local environment, the Cretan, and a significantly different, the environment of western Macedonia. The project will progressively be developed from the cognitive, to emotional and psychomotor level, so the circle of knowledge expands, skills are cultivated, and psyche matures (AF).

As teachers declared in the interviews, the interdisciplinary/multidisciplinary approach of the project topics supported significantly by school teachers who linked various courses to the project issues. Further focus on certain courses, such as History, Biology, Environmental Science and Informatics, amplified by the respective specialties of the guidance teachers. In the places where we live, the natural environment (natural resources and processes) interacts with society (social groups and functions) resulting various interrelationships, which cannot be studied through a unique cognitive domain. The environmental issues are extremely complex and complicated so they do not accept unambiguous visas but require interdisciplinary approaches (Flogaiti, 2006). School surveys for local environments can be used in the conquest of scientific knowledge in science lessons (Carlsen, 2001).

As Teacher 3 said, "teachers tried in any teaching to explore alternative ideas of students such as Driver *et al* (2000) have documented, as regards the natural environment, ecosystems, energy flow and relations among the organizations. They insisted in, and seek to discuss and analyze them, as much as possible, to help the review of misconceptions and fill the learning gaps… In particular, discussed issues of pollution and eutrophication of lakes, aesthetic degradation and garbage, trophic webs, the energy flow in the lake ecosystem, biomass

and energy pyramid in the terrestrial ecosystems of forests were didactic objects of the school curriculum. Students and teachers admired the beauty of the variety of the species of forest tree of oaks, poplars, sycamores, osier, willow, beech, chestnut the aquatic ecosystems of Kastoria and Prespes lakes, the artificial Plastira's lake, which are lacking in Crete. Students had the opportunity to become acquainted with the life of the brown bear and the wolf in a protected natural mountain environment, entirely different from the Mediterranean phryganic ecosystem of Crete. They impressed with the large engineering projects, that are missing or there are on a small scale in Crete, as the Egnatia Highway, the highway tunnels, the river dam of Strymon, the artificial lake Kerkini and special constructions such as the floating bridge to St. Achillion in small Prespa (FR).

In terms of laboratory teaching, students observed phytoplankton and benthic organisms in stereoscopes, which teachers of the Kastoria Educational Environmental Centre sampled for the purposes of the project. They used identification keys for family, genera and species, thus realized the diversity of the invisible world, applying the scientific method on systematic classification of organisms, based on specific criteria. According to Vygotsky (1997), cognitive development is a process inseparable from the historic-social dimension and the cultural context in which it occurs. "The aim was to compare the historical evolution of spaced apart regions of Macedonia and Crete through the monuments and archeological remains of each region (AF)."The students were able to see monuments from pre to historical periods. The introduction to primitive life in Dispilio, in the Mesolithic era, and the Minoan civilization in Neolithic, extended their knowledge in the past and connect their roots with those of the rest Greeks" (Teacher E1). As is clear from the photographs of the archive material, Hellenistic monuments to St. Achillion, Byzantine monasteries of Meteora and Spiliotissa, mansions of the 18th and 19th century of Kastoria brought the historical line to the contemporary rural and urban settlements in Thessaly, Macedonia and Crete.

The ecological balance in the composition of the forest and lake bio-communities, as well as options of their management, are imperative need in our days for a better quality of life, combined with the promotion of ESD values, these ecological sustainability, beauty, responsibility, social justice, solidarity and tolerance (Flogaiti, 2006). "The students focused on canyons management practices of their area, the wording of proposals for grazing, fire safety, forest management, the expulsion of trespassers from the Epanosifi, during the discussion with the Mayor and the Abbot of the monastery" (Teacher E2).

The project subject, itself, is directly related to the Economic and Management courses and Administration Business taught in Lyceums. Agro tourism, as type of rural areas development, was the central issue of the project and the "Callisto" program. Agro tourism is a mild type of sustainable touristic development and multi-activity in rural areas, which aims visitors to learn more and in depth the rural areas, farming activities, local products, traditional cuisine and daily life of the

residents, the cultural elements and the authentic features of the visiting area. To offer incentives to productive, cultural and developmental forces of rural areas, for economic and social development, thus contributing to sustainable environmental (Agrotouristiki, 2007). Hostels, traditional food and accommodations which students visited in Houdetsi and San Germanos, the Brown Bear and Wolf of Arcturus protection programs and are interesting management proposals for natural environments and traditional settlements that entered under the microscope of the small researchers, maybe future entrepreneurs, making praxis the school theory. The occupations of the inhabitants, the local economy, the traditional crops with beans in Prespa, sultanas raisin and table grape in Heraklion, wine and oil production in Crete, traditional fishing in Prespa and Kastoria, livestock with cows in Macedonia, and goats in Crete gave excellent material for comparisons and reviews. "The visit to the water dam of the artificial lake Kerkini offered many ideas and generated extended discussion on the management of limited water resources in Crete, which is a hot issue in students' villages (Teacher E1).

"During the implementation of the project, students had the opportunity to learn and to use Information and Communication Technologies (ICTs) (Teacher E2). They made use of the web exploring and multimedia tools to collect information on the assigned tasks". In the computer course, they edited texts, spreadsheets, video and sound, producing specialized digital material for the needs of the project" (Teacher E2).

Regarding the artistic approach, as transversal action running all project objects, students, knowing well Cretan folk poetry and music, drew short songs-"madinades" and a long poem, at fifteen syllables, where summarized their experience from the educational visit in Macedonia.

Levels of Educational Actions

Four levels defined the hierarchy of learning outputs with grading difficulty skills, such as the informational (collect information, data), the organizational (comparison, categorization, layout, ordering), the analytical (data correlation) and practical (explanation, interpretations, predictions, reviews, reorganizations) (Matsaggouras, 1997). A lot of information, data, was collected, in many ways, which was pooled, coded and correlated in order to explain, to arise conclusions, to make assumptions and proposals. DTM involves students in investigations to satisfy their curiosity, and they succeed it when they have constructed mental models which adequately explain their experiences (Victor &Kellough, 2003). The new knowledge of the different ecosystems, historical monuments and social life in Macedonia compared with the preexisting of the Cretan environment of their origin, in order to be integrated and utilized, since, according to the Novak (2002), the new knowledge, is relating to the earlier, and then occurs the conceptual change.

According to the Strategy of UNECE (2005), ESD must use a wide range of educational methods, participative and oriented, in finding solutions tailored to learners. Beyond the traditional methods must be used information and communication technology (ICT), philosophical exploration and values clarification with discussions, conceptual mapping, simulations, "scenarios", modelling, role playing, educational games, surveys, case studies, visits and field work, projects, study of best practices and problem solving.

In the cognitive goals of AF is written "the students get to know the forest bio-community, to develop skills of observation, recording and classification of life in the forests". "The field work was based on the observation, data collection and recording following by describing hypothetical applications….The observations and data recorded in worksheets and the team investigates and identifies human interventions, such as roads, settlements, logging operations, tourism facilities, etc. and realizes the interaction and interdependence of the natural environment to the economy and development" (FR).." "The worksheets helped students to focus on important points, to understand and clarify mechanisms, while trying to fill in, as for example in the lakeside forest" (Teacher E3).

Evaluation and Reflection

Systematic evaluation did not design and not done in the project, as it is apparent from the analysis of archival material. The carried out project research, as evaluation study, emerged many elements of assessment, self-evaluation and meta-cognition (Kalathaki, 2015). In the FR stated that "done internal formative evaluation during the project implementation and a final one at the end". Teachers and students expressed opinions, undertook initiatives, and were active after consultations and conciliations (formative assessment). 'Throughout the project were made comments and amendments with assessment discussions when needed ... We were saying what we liked and what did not like to us, what should be done, so we understand we assess" (Teacher E1).

We could say that a kind of internal, final, evaluation was done, by group discussion and brainstorming, on the return trip from the educational visit in North Greece. It was an attempt of evaluation with several metacognitive elements "Teachers and students focused on situations and behaviors developed during the project implementation and how these impacted on what each one received from participating in the project" (Teacher 1). Students expressed their experiences and what impressed them, as otherwise viewed for first time in their lives. "It was a dream trip with guide the nature, that God has created with much precise and care." In this evaluation, was used a poster, from which, the following excerpts isolated: "When people respect housemates (animals and plants) in our house, the Earth, live in harmony with fellows," "Start from now, do not lose any time, every second counts eternal ... Protect our forests".

The drawing of the FR, in the end of the project and the presentation of its results in the school and local community, gave the chance of seen numerous aspects, from different angles, and expression of many and various opinions on what was valuable to be presented. "Became, essentially, a criticism, self-assessment of the role that each one played in the project and what best could had done" (Teacher E1).

Evaluation of the program was also the acceptance of oral presentation of it, in the 4th Congress of the Pan-Hellenic Union of Teachers for the Environmental Education (PEEKPE) entitled "Biodiversity and Quality of Life: a Methodological Framework for the Implementation of School Education Projects for Sustainable Development" (Kalathaki *et al*, 2008). The conference subject was "Towards Sustainable Development. Natural Resources, Society, Environmental Education "and took place in Nafplio, 12-14 December 2008.

CONCLUSIONS

Concluding, the research revealed that the project was designed and implemented to meet the principles of the EE and ESD. It is the application case of general principles of DTM in different learning environments inside and outside the classroom, in the field and in the society. A varied teaching techniques, ICTs and different learning environments were used. Students and teachers, in collaboration with authorities, bodies, scientists, business and experts, negotiated with a great number of issues of the school curriculum, the everyday and quality of life, in a holistic approach of the project.

There is a need to emphasize the importance of understanding by students of how scientists study the natural world and not only in learning the scientific content. Helping students to carry out research on environmental issues and take action then as active, environmentally literate citizens, the environmental knowledge effectively achieved. In the future will need to think and work in difficult paths because our distant future will depend more on our ability to analyze, to formulate alternative questions and to make our own decisions when we need to do (Scott, 2007). That's why learning must be faced as participation and the Sciences as practice.

Acknowledgments

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