The Use of GIS for Understanding Geographical and Environmental Concepts – Creating Teaching Material

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Abstract

This paper presents educational material that has been developed and will be utilised in an Environmental Education program entitled "Young researchers in a countryside path". It pertains to primary school pupils of 5th and 6th grade, who, as young researchers, follow a countryside path, use the Global Positioning System (GPS) and perform specific activities, collect data and record their observations on worksheets. On their return to the PC lab, they put the data collected in the field into a Geographic Information System (GIS) in order to visualize their findings and create their own thematic map. Through these activities and the use of new technologies, students acquire knowledge, develop skills and abilities, and become aware of environmental issues always in accordance to the goals and objectives of Greek Cross Thematic Curriculum Framework for Compulsory Education and subjects syllabi. By observing, recording, managing and analyzing their spatial and environmental data, and forming cases that are verified in the dynamic nature of space and time, students go on to make suggestions and drawing conclusions from their work.

1 Introduction: Theoretical Framework of the Research

A significant number of studies indicate that pupils have difficulties in understanding basic geographical, geological and environmental concepts such as longitude, latitude, scale, location, erosion, flora, fauna, photosynthesis etc. (PARASKEVAS et al. 2010, Osborne & FREYBERG 1985, GORIA & PAPADOPOULOU 2008). Additionally, students come to school with alternative ideas on plants' functions and their role in natural ecosystems (BARMAN et al. 2006), as well as the impact on human activities on nature. All these facts create obstacles to pupils' deep understanding of nature and development of awareness for their local environment and its protection. Furthermore, although these issues make up an important part of several subject curricula taught in elementary school, because of traditional, teacher-centered teaching methods used by the majority of primary teachers in classroom practice, pupils' effective learning is limited (BRANSFORD et al. 1999, VOSNIADOU 2001a, KLONARI & LAINA 2010). Lack of knowledge and teaching skills to approach these issues (KLONARI 2004) prohibits any attempt for the implementation of environmental awareness programs (MEINHOLD & MALKUS 2005). Moreover, the question of the interpretation and use of geographical terms and symbols (e.g. altitude, contours, geographical coordinates of a position, etc.) is considered very important and there is often a problem in pupils understanding and interpreting them (BLAUT 1997). Children cannot understand these concepts abstract for their age and often give up trying to understand if they are not encouraged to acquire this knowledge through experiential learning (PIAGET 1971). Researchers (SHIN 2006, KLONARI et al. 2011) argue that if students use the fieldwork for exploration and the use

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geographic tools, they will acquire the knowledge with less pressure. Moreover, it is known that fieldwork (DUSIC & SMITH 2004) allows students to connect abstract scientific ideas to their own personal observations through all their senses. It also promotes a deeper understanding of the investigative approaches that are part of the sciences. Environment's direct observation (HOWARTH & SLINGSBY 2006) and scientific research out of classroom is fundamental in understanding science and constitutes a source of inspiration and motivation for new discoveries. CAMPBELL (1994) argues that many ideas in science have been inspired by environmental observation. Fieldwork could be incorporated in science as a series of outdoor learning activities during a semester.

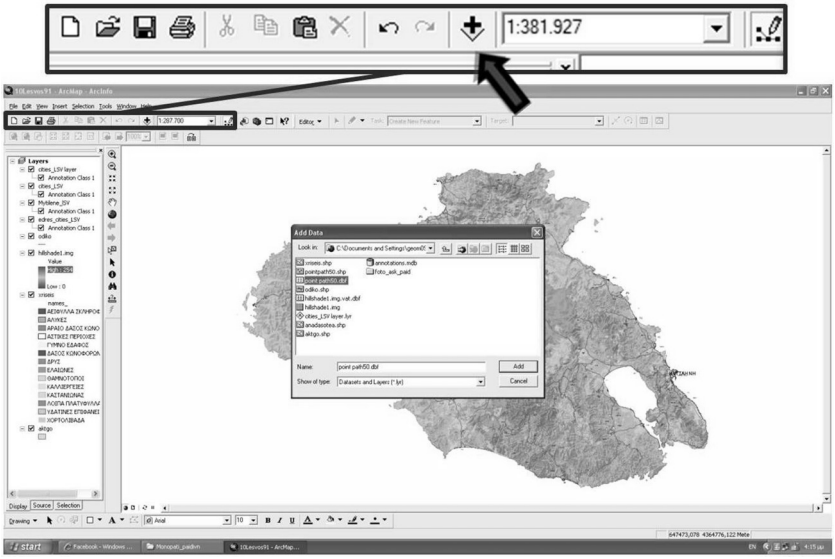

Fig. 1: This figure is used when detailed instructions for the input of datainto the GIS software are given to the students

In the Greek Curriculum, there are no clear recommendations to teachers about outdoors teaching and this is a reason why in many training programs for teachers this kind of teaching is absent. However, on the basis of the international reality and experience, fieldwork should be an integral part of any curriculum. For some subjects, such as Geography and Environmental Education, these are a prerequisite for teaching.

2 Rationale of the Research

This research was designed in order to investigate the effectiveness of the interdisciplinary approach (GAGNE et al. 1992) in fieldwork, and students ability of using new technologies (especially GPS and GIS) within an Environmental Education program. This is an innovative activity for 5th and 6th grades pupils, and gives the opportunity for a cross thematic approach since it is related to Environmental Education, Geography, History, Mathematics, Arts.

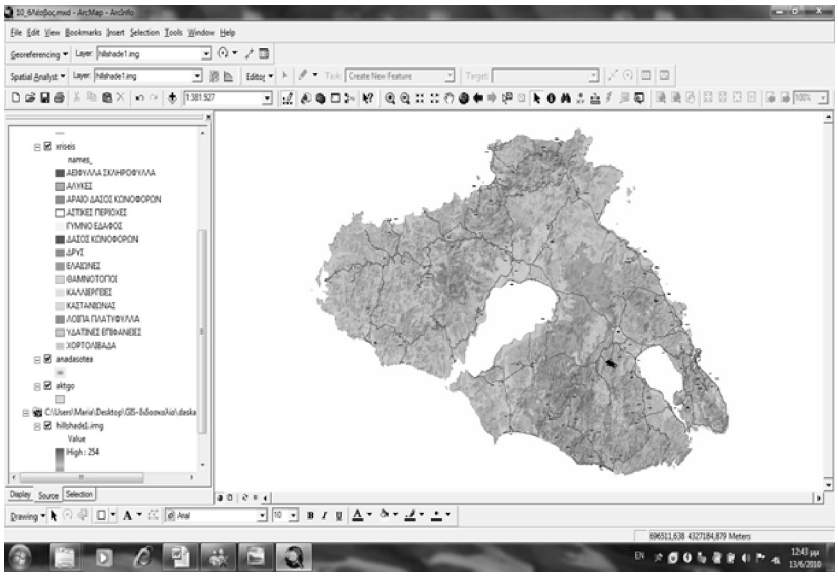

Fig. 2: Initial appearance of point data from students' recordings at the trail onto the map of the island

The lack of relevant research in the Greek reality has been the motivation to conduct this research. Pupils will use GPS (Geographical Positioning System) for data collection in the field and the next day in the PC lab. Using a GIS software (e.g. ArcMap), they will visualise these data and make all the other relevant activities. This approach is an innovative application in the educational process and a literature review found no similar applications in the primary schools of Greece. The use of GPS is based on a global satellite navigation system that provides reliable positioning and accurate information about it (latitude and longitude coordinates, altitude, etc.) "at anytime and anywhere on Earth" where there is a clear line of sight to four or more GPS satellites. The GPS consists of three parts: satellites orbiting the Earth, monitoring stations on Earth, and GPS receivers owned by users. Each GPS receiver then provides a three-dimensional position (latitude, longitude and altitude) plus the time of the record. The introduction of data into ArcMap and their visualisation will provide the map of the trail on the map of Lesvos Island.

This scenario of the activity will help students to become "young researchers" of a specific trail in countryside. Through this exploration, the student has an active role in the acquisition of knowledge (ALIBRANDI & PALMER-MOLONEY 2001). Our aim is by guided discovery (BRUNER 1961, 1990) to have a pleasant and fun way of acquiring knowledge, to foster skills and abilities regarding the environment and space while achieving an integrated development of their personality. We want to achieve not only the cognitive objectives of the curriculum, but also the psychological and emotional ones. (BLOOM et al. 1956). By pursuing the necessary requirements and conditions that will provide an incentive for students to move beyond the mere and sterile presentation of factual knowledge, they will acquire knowledge, skills and competencies that meet the current interests of students. The use and learning of the GIS will contribute to the education of current students, and hence tomor-

row's citizens, as a tool that has entered the life of modern Greeks and tends to establish itself in everyday life.

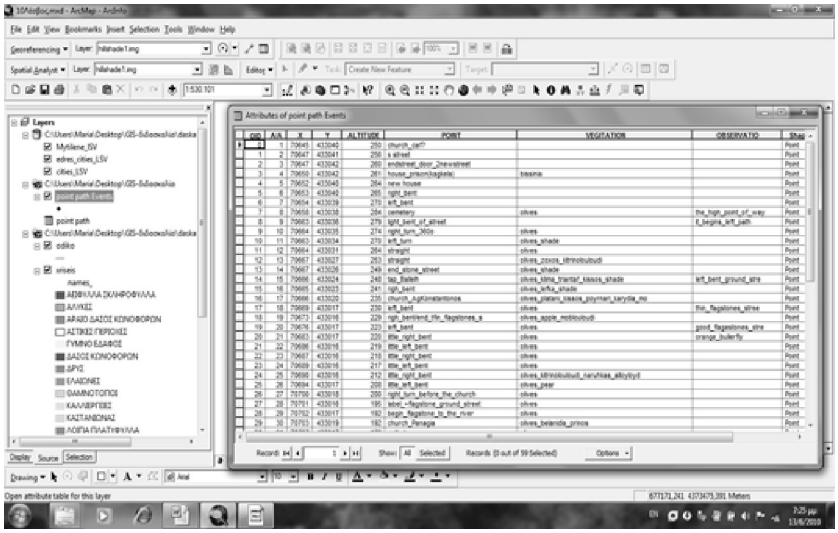

Fig. 3: Appearance of all descriptive data (plants, animals etc) collected by the students at their recording points

This is the reason we decided to develop this training package and implement it in the next school year. Results of its application will be evaluated with a particular sample of students. Finally, based on the results generated, we will proceed with improvements or corrections of the educational material.

To sum up, this specific educational material incorporates experiential learning, field research, and experimentation, skill development in data processing, and expansion and use of new technologies. The design of the teaching material allows the use of students' ideas that may arise from research in the field and experimental and data processing in the production of scientific knowledge. The design of a teacher's manual also uses research data on identifying difficulties in teaching the relevant topics.

3 Educational Tools

3.1 Objective

Objective of the project is the creation of an educational package in accordance with the above theoretical framework. It will used during an environmental education program with students in the fifth and the sixth grade, and assessed its effectiveness in the educational process and in achieving the following objectives.

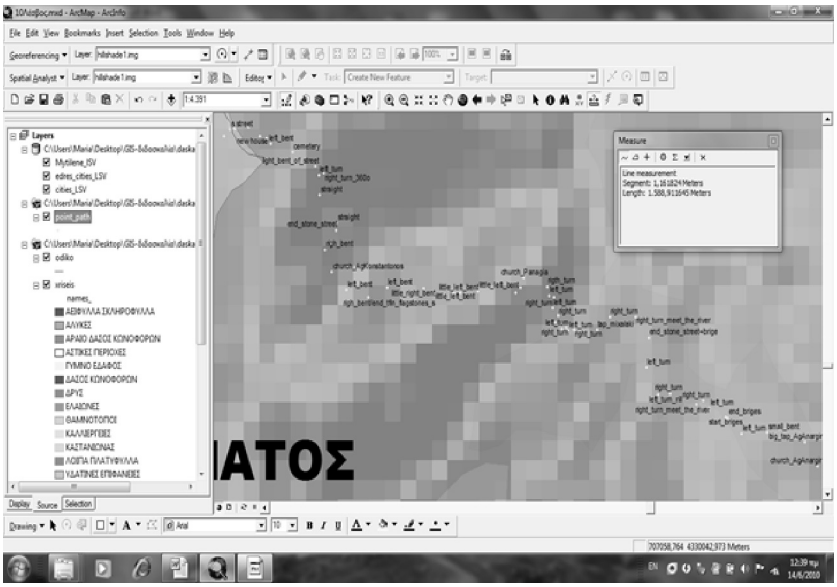

Fig. 4: The students, after giving names to the points recorded, they measure the distance they walked in the trail in digital map

3.2 Objectives of the educational material

With fieldwork and the use of new technologies beyond the objective stated in the general part, students will:

- distinguish between geographical concepts such as altitude and coordinates of a position
- be able to make measurements using GPS and record them
- be able to process geographic information and visualize it (create map) by using GIS
- identify flora and fauna and the relationships between plant and animal organisms
- observe effects of the physical processes shaping the morphology of the area and make hypothetical scenarios based on them
- reflect on how human actions affect the natural environment
- present their work and their findings using new technologies
- develop team spirit and exploratory work in the classroom and the natural environment
- love interaction with nature and raise awareness by actively participating in its protection, as children today and as environmentally responsible citizens tomorrow.

3.3 Application level and student sample

The scenario is designed for a two-day environmental program. The same application could also be used for older children with the same tools but with another geographical background and other nature trails in the nature of Greece and Europe, with some adjustments. It is estimated that the time required for the implementation of this environmental program, that is collecting geographic and environmental data and processing, managing new tech-

nologies and students making a map in order to achieve the initially set objectives, is two days.

Our sample is estimated to include 60-70 students and our operations are divided into those before visiting the field, those during the visit to the field and exploring the path and those after exploring and evaluating the program through the work performed by the students.

The training package that will be used in this research will include: recording/ monitoring questionnaires, which will be completed by groups of students in the field, and educational cards showing species of the local flora and fauna, which are designed to help students recognize and identify on-site plant and animal species. It will also include worksheets and evaluation forms in the classroom through which students will show not as much as to what they have learned but mostly as to whether students have developed skills related to methodology and the use of new technologies in school (cooperation , tools, ability to mentally organize a map, work implementation, etc.).

The package also includes detailed instructions for each activity that guide the teacher who decides to carry out this program even if he/she has no prior knowledge of the subject.

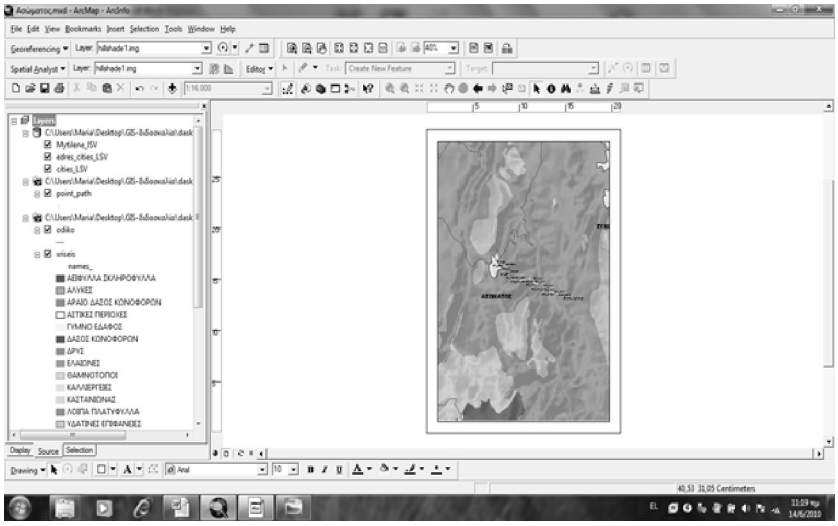

Fig. 5: The students move from data collected to their own map. They create legend, orientation and scale.

3.3.1 Description of the educational process before visiting the area

A teacher who intends to work with students in the field needs to be very careful and methodical, and be sure to plan a correct and complete schedule of activities. This means that he/she should visit the trail before going out with the students and conduct a series of actions as described below:

- Mapping the whole way
- Search and record all items of interest to be reported, both in exploration with the children and the preparation of worksheets.

- Timing of the route
- Gather all necessary equipment for the recording
- Prepare questionnaires
- Cards listing the plants and animals of the region)
- Provision and collection of tools for measuring and observing which will be used in the field (GPS, microscopes)

3.3.2 During the students' visit on the trail

The students are welcomed, supplied with necessary information and divided into groups of 4-5 individuals. Each group assumes different tasks/roles, e.g. recording sheets, geographer, observation sheets, GPS-technician, microscopes expert, a collecting plants and animals biologist, plant and animal cards holder, in the field. Together they collect all the information that is necessary to carry out and present their work after the exploration of the path.

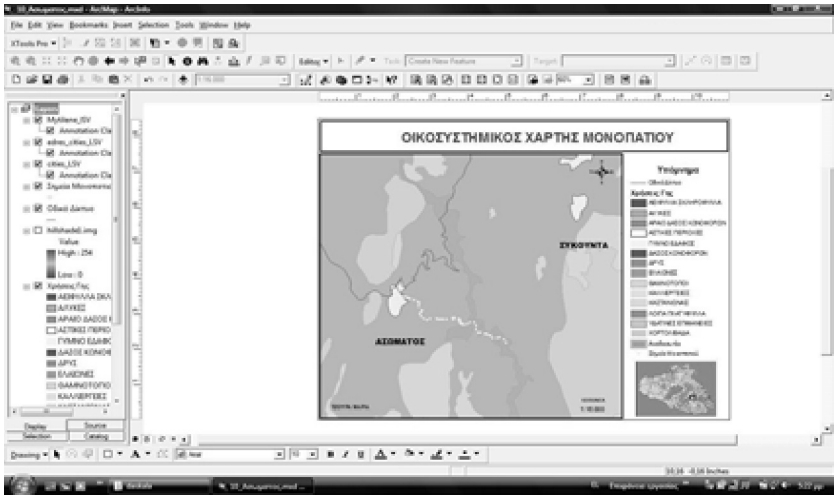

Fig. 6: The final map

While in the field, student groups start the exploration, collection and recording of data onto the questionnaires. Specifically we have designed: a) A recording sheet to gather information and geographic data which records the latitude, longitude and altitude of 50 specifically chosen items and b) an observation sheet to note the plants and animals that students will encounter at preselected points of observation. Recording of this information is assisted by the detailed information given on specific forms and by the plant and animal cards. The recording of evidence and the entire collection and examination of the material the students, are performed through the use of GPS, a children's microscope and a camera. So the student group is experiencing the process of creating an effective small group of researchers who apply scientific methods (observation, identification, collection, description, registration, classification, etc.).

It should also be noted that for each pupil's worksheet throughout the phases of the program a teacher's corresponding educational package has been designed providing the necessary cognitive information and educational activities.

3.3.3 After the visit of the trail

The student groups return to the computer laboratory to put geographic data recorded, as well as of other observational data from the natural environment, into the computer. The initial data, upon processing, will provide them with the map of the trail while the second list of data will provide the tables with descriptive information for each point on the route linking the spatial to the descriptive information.

The work of students will also provide data to evaluate our educational package, which is the second objective of our research. For this task we have created three student questionnaires and an evaluation questionnaire. In these, the steps which are to be taken by the students to use their data are described in depth, while projecting the images of instructions for each corresponding work on the screen of a PC to be viewed by students.

Here are some excerpts from the student and corresponding teacher worksheets:

Table 1: Table where students record geographical coordinates with the use of a GPS

No	Longitude x	Latitude y	Altitude	Recording Point
1	70645	433040	250	Assomatos Church
2				

Table 2: Table where students record plants & animals at the recording points

No	Recording Point	Plants encountered	Animals encountered	Comments
1	Assomatos Church			
2				

4 Implementation Problems or Research

The educational material will be applied, in late February, to a sample of 60-70 elementary school pupils, in Mytilene, Lesvos Island, Greece. Children explore an environmental trail of Lesvos, collect their data and next day, they evaluate data in a GIS software at the GIS laboratory of the Department of Geography (University of the Aegean), due to the lack of modern computer laboratories in public schools. The lack of materials and the lack of corresponding infrastructure deprive the students, from an organised knowledge about structure and attribute of earth. Concluding, it's time to start a discussion on the upgrading of geographical and environmental education in Greece's educational community which will set the base in the elementary education, in this sensitive age, where the personality of responsible and energy people begins to build.

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