Using Virtual Globes and GIS in Digital Geography Textbooks

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Abstract

Nowadays, the teaching of Geography in compulsory education integrates modern Technologies of Information and Communication (ICTs), such as Geographical Information Systems (GIS) and Virtual Globes. The capabilities of a GIS, like the ability to accurately map spatial locations, the multiple of ways to represent the different attributes and characteristics of geographical entities and the ability to create dynamic maps are undeniable. Virtual Globes combine satellite images with a variety of ancillary data, to support a large number of Earth Science applications. On the other hand, the integration within the different subjects and computer infrastructure of contemporary open ICTs provides opportunities for students to engage in innovative and creative learning processes. This paper presents the results of a study on the use of the Google Maps and Google Earth platforms to enrich the digital versions of Geography textbooks in primary and secondary education.

Keywords

Geography education, GIS, Google Api, Google Maps, Google Earth

Introduction

In the last decades, Geographical Information Systems (GIS), a set of integrated software programs designed to store, retrieve, manipulate, analyse and display geographical information, have emerged as an essential tool, playing a decisive role in a number of human activities of everyday life (Koutsopoulos 2005). GISs are therefore an important educational tool for primary and secondary education throughout Europe. They are relevant to many educational subjects, and particularly to Geography and geographical education (Klonari et al. 2009). Geography, as an interdisciplinary subject, lends itself to the introduction of innovative teaching and learning approaches via the use of ICTs. Specifically GIS, with its emphasis on digital information processing and analysis, can contribute greatly to the fusion of various geography-related disciplines that incorporate the spatial dimension (Patterson 2007). While GIS can have a significant impact on the teaching and learning of spatial thinking, it must be incorporated into a standards-based

curriculum and used alongside other types of tools in the classroom (CSTS 2005).

GIS in Greek Schools

In Greek compulsory education, there is no direct reference to GIS in the formal curricula except for the case of the book of Geology-Geography of the 1st grade of lower secondary education (i.e. 12 to 13 year olds). Nevertheless, teachers familiar with the respective technology might sometimes refer to or use geo-informatics in class. According to the limited number of published researches carried out in Greece regarding the use of GIS in secondary education, not only do they formally not exist in the curricula and are therefore not used in teaching and learning, they also still constitute a 'black box' for most teachers (Klonari 2009). During 2011 and in the framework of the action called "DIGITAL SCHOOL: Specifying a Digital Educational Platform, Building and Operating an Educational Knowledge Base, Adapting and Annotating Learning Objects with Educational Metadata, Building the Infrastructure to Support Exemplary Teaching Practices and the Use of the Participatory Web", co-funded by the European Union and the Greek State under the auspices of the Greek National Strategic Reference Framework (NSRF), created teams, of primary and secondary education teachers managed by academics (professors), responsible for the development of learning objects with educational metadata for several subjects, including the subject of "Geography and Geology - Geography".

The goal of this research is to investigate ways of development of Digital Education Material which would enrich the digital edition of Geography school textbooks. Some of the learning objects which have been developed by the team are relative to GIS. Considering the fact that the teaching of GIS involves two aspects: teaching *about* GIS and teaching *with* GIS (Sui 1995), our approach is that students should have the opportunity to

- combine the learning objects with basic concepts of computer science;
- modify material and test their attempts and ideas;
- search for solutions to their problems, with "networking and engagement in research carried out by wider and disparate communities" (Kynigos 2007).

Google Maps Application Programming Interface (API)

Google launched the Google Maps JavaScript API in June 2005 to allow developers to integrate Google Maps into their websites. It is a free service if used in freely and publicly accessible websites. By using the Google Maps API, it is possible to embed Google Maps into an external website where specific data can be overlaid.

Virtual Globes - Google Earth API

One type of Internet-based GIS is Virtual Globes. Virtual Globes are similar to Desk Globes with the additional capability of simultaneously representing many different thematic views of the Earth's surface. They show spatial data at multiple scales and in multiple ways, including photos and videos. The user can seamlessly zoom into the data, rotate the view, and tilt the image to see the terrain in three dimensions. Virtual Globes display satellite imagery at various resolutions, aerial photos, topographic maps, elevation data, along with GIS layers like roads, administrative boundaries, points of interests, and place names overlaid on each other using a Web interface (Rakshit and Himmelberger 2008). The entire planet is covered, with around one-third of all land depicted at such high resolution that individual trees, cars, and the households of 3 billion people, can be seen (Rakshit and Himmelberger 2008). The Google Earth Plug-in and its JavaScript API allow users to embed Google Earth, a true 3D digital globe, into web pages. Using the API you

can draw markers and lines, drape images over the terrain, add 3D models, or load KML files, allowing you to build sophisticated 3D map applications. Below we present examples, which represent categories of geography textbook enrichment in the Google environment.

KML files

KML (Keyhole Markup Language) is a simple XML notation for expressing geographical data. KMZ is a zipped KML file. Students can download KML files and open them with Google Earth locally. For example, and for the lesson of different kinds of positioning a place, explore the file gbg01_alexandroupoli.kmz that is free to everyone (e.g. Relative and absolute position).

KML embedded in web pages

By using the Google Earth Plug-in, a KML file can be embedded in web pages (e.g. European Seas).

Virtual Globe and Tours

Taking advantage of the "tour" feature of kml files together with representational capabilities, of depicting lines and displaying data, virtual tours can be constructed on the Earth's surface. It uses the JavaScript language (e.g. Magellan's expedition).

Figure 1. Magellan's expedition

Google Maps and Visualization of Geographical data

In this case, an interactive JavaScript application can be employed that connects the map area, (on the top of the screen in Figure 3) with a column graph (on the bottom of the screen in Figure 3). It combines the strength of a graphical representation of data with the accuracy of geographical positioning and the encyclopedias available on the internet. In the case of an area in Greece, for example, by clicking on any bar of the graph, a balloon emerges on the corresponding position in the map, with a relative link to the Greek version of Wikipedia. The code is open access and can easily be accessed directly from the browser (by selecting 'view source'), modifiable and reusable so that the students can use it for another set of data (e.g. European mountains).

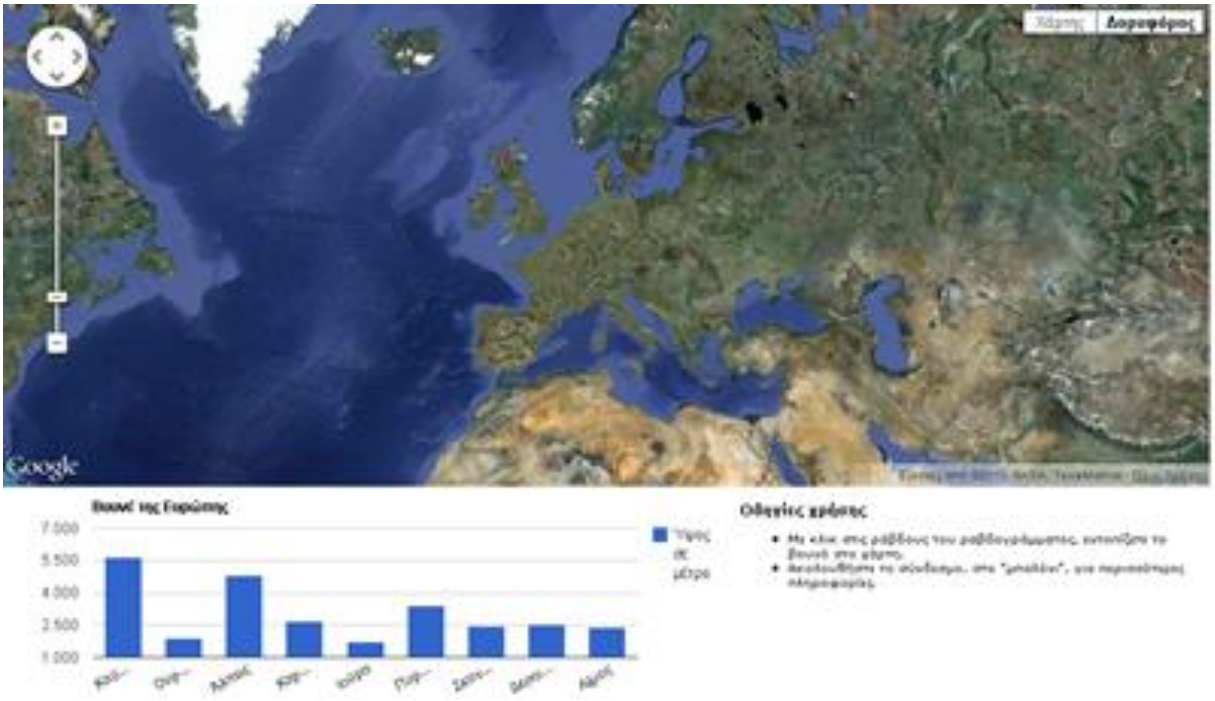

Figure 2. European mountains

Google Maps and Measurement Tools

Measuring different phenomena is an integral part of a geographer's profession. An application, in the Google Maps JavaScript API, is able to query and use the data stored in the data base the interactive Google Maps to produce graphical representations of such queries. For example, starting from the map area, students can trace any route, on land or sea, and see the height or depth of any point of the specific route in a graph (Height Meter Tool).

Figure 3. Height meter tool for a route

Conclusions

Geography lessons today can be supported by using the powerful and dynamic technology of GIS. The digital versions of geography textbooks should, therefore, incorporate the use of GIS. Teaching geography using such tools could allow the students to get involved with new technologies not only to visualize geography-related data; they can also investigate the existing databases and produce their own queries and graphical outputs, such as graphs and maps. Moreover, they also have the opportunity to engage with programming languages and other components of computer science and familiarize themselves with different aspects of human thought, as it changes under the tremendous impact of digital technology.

Web pages

European Seas. http://digitalschool.minedu.gov.gr/modules/ebook/show.php/DSGYM-B106/382/2534,9788/extras/gbg12_eu_europeanseas/index.html

European mountains. http://digitalschool.minedu.gov.gr/modules/ebook/show.php/DSGYM-B106/382/2534,9792/extras/gbg16_europeanmountain/index.html

Relative and absolute position. http://digitalschool.minedu.gov.gr/modules/ebook/show.php/DSGYM-B106/382/2534,9780/extras/gbg01_alexandroupoli/gbg01_alexandroupoli.kmz

Magellan's expedition. http://digitalschool.minedu.gov.gr/modules/ebook/show.php/DSGL100/418/2821,10662/extras/geocoder/MagellanTour.html

Height Meter Tool. http://digitalschool.minedu.gov.gr/modules/ebook/show.php/DSGL100/418/2821,10662/extras/geocoder/MultiAndDynamicHeightMeterC_GR.html

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