

Science Experimental Teaching through the Use of Geographic Information Systems

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Abstract: Since 1996, the Ciência-Viva Program has supported projects whose aim is to encourage the use of experimental science learning, involving scientific and school communities in an exchange of knowledge and resources. Within this program ISEGI-UNL, in a partnership with ESRI-Portugal and two secondary schools, is leading an initiative promoting a learning process centered on experience, in which the focus is given to the use of geographic information technologies (GIS and GPS). Taking as a starting point the concepts and principles of the various disciplines integrating the curricula, the goal is to give students research activities directed at the resolution of problems and relevant tasks, in which space, as the stage for the many relations between phenomena, is the integrating element of learning experiences and tends to supply the privileged context for the establishment of an analysis and exploration framework.

Keywords: GIS, Learning Experiences, Spatial Analysis Skills, Experimental Teaching

1. INTRODUCTION

Aiming to develop activities in middle schools and in high schools and also promoting experimental teaching methods using Geographic Information Technologies (GIT) tools, the Portuguese Instituto Superior de Estatística e Gestão de Informação from the New University of Lisbon (ISEGI-UNL) developed a project that, in part, was originated from the idea presented in a Master's theses in Geographic Information System & Science [1]. ISEGI-UNL had, in the past, supported some activities (such as GIS-Day) in two schools in the Lisbon area (Pinhal Novo Secondary School – ESPN - and Maria Amália Vaz de Carvalho Secondary School - ESMAVC). The project, initially called ConSIG, was presented here in San Diego at ESRI EdUC in 2006 [2]. The final project, now named ConTIG, was submitted to the National Agency for Scientific and Technologic Culture (in Portugal) – “Ciência Viva” program, and was approved in December 2006. The project is coordinated by ISEGI-UNL and has both secondary schools as partners, as well as ESRI – Portugal.

Among the goals of the project, are the following:

- Develop spatial analysis skills in students,
- Develop research and group work skills,
- Develop critical sense about spatial planning,
- Alert to the importance of geographic information in daily life,
- Create maps for various purposes,
- Share these learning experiences, the materials and disclose the project in seminars and in teachers meetings.

It is also our goal to demonstrate the potential of GIT in better organizing and managing the *curricula*, according to the guiding principles of the Portuguese standards and national *curricula* that, among other things, states that one must use a diversity of methods, activities and strategies in education, especially using information and communication technologies, to promote skill development in a lifelong learning perspective [3].

To achieve these goals, various activities have been developed:

- 1- An **initial planning** that consisted in determine goals, constraints and methods of communicating between ISEGI-UNL and the other partners (ESRI Portugal and both schools). Then, some work groups were formed and some equipment was acquired (PDA equipped with GPS and ArcPad licenses and also ArcView licenses).
- 2- The second phase was one of **developing the project and producing contents**. Materials and guiding tutorials (for teachers and for students) were produced, including guidelines for the learning experiences. There is also a WebGIS tool that will support some of the learning experiences.
- 3- **Getting students to experiment the contents** will consist on getting them to try and do the tasks of the learning experiences. This part is functioning with positive results on students and teachers enthusiasm.
- 4- The **dissemination of the results** (even preliminary) aims to present the project through participation in conferences and meetings related to these topics (GIS and education).
- 5- At the end there will be an **evaluation of the project** through a detailed report based on the results.

This project was completed in June 2008, with the end of the school year. However, it is expected that the materials produced will be used by other students and other schools, even after the official completion of the project. These materials are already available online, in Portuguese, (<http://ubu.isegi.unl.pt/labnt-projects/contig>). Both the completed experiences as well as the ones that are still being implemented at the present time (June 2008, classes are still going on) should be published at the website.

As for the coordinator and ContIG partners, their functions are:

- ISEGI-UNL coordinates the activities from an administrative and scientific point of view. Therefore, they organize the follow-up meetings, produces reports, manages the finances and organizes some events (like the GIS-Day 2007 event). They are also responsible for defining guidelines on methods, conceiving and producing some scientific contents, the Web page and the WebGIS application.
- ESRI-Portugal is responsible for technical support to schools and also for some initial teachers training in GIS technologies. They are also present in the follow-up meetings and events.

- Teachers of the adherent schools involved are responsible for conceiving and implementing the pilote experiences. They produce all the specific documents for each learning experiences and are responsible for getting students to participate in a set of meaningful activities. They are also present in the follow-up meetings and events; participate in workshops and training sessions.

2. THE FIRST LEARNING EXPERIENCES

The learning experiences were designed to lead students to develop different kind of skills through experience learning using GIT (including GIS and GPS).

Through different school subjects, we expect to involve students in research activities leading them to problem solving. Assuming that both natural and human phenomena occur in a common element (space), GIS is the tool that can emphasize the process of research leading students to better understand spatial dimension. Under this perspective, GIS tools tend to be seen as education resources and analysis tools that can support decisions.

During 2007/2008 school year, we prepared some learning experiences that were carried out in both schools and also in two other schools. Teachers from all four schools prepared materials to use in their classes, according to the subjects and levels that they were teaching (figures 1 and 2). We were concern about working and taking into consideration the necessity of working at different scales and promoting the acquisition of different spatial analysis skills.

Learning experiences	Scale			
	Local/ Regional	National	European	Global
1- Arrábida Natural Park and the human experience	X			
2- Locate and explore Palmela's county	X			
3- Gastronomic and touristic roadmap	X			
4- Developing contrasts in today's world				X
5- Portugal in the EU context			X	
6- Mapping european cities (ArcView3 exercise)			X	X
7- Portuguese typical foods		X		
8- Portugal's physical geography		X		

Figure 1 – Learning experiences according to scale.

Learning experiences	Spatial Analysis Skills and Competences										
	Data acquisition	Data integration	Data visualization	Cartographic representation	Data validation	Search operation	Geoprocessing	Network analysis	3D analysis	Raster analysis	Graphic representation
1- Arrábida Natural Park and the human experience	X	X	X	X	X	X	X			X	
2- Locate and explore Palmela's county		X	X	X	X	X	X				X
3- Gastronomic and touristic roadmap	X	X	X	X	X	X	X				
4- Developing contrasts in today's world		X	X	X		X	X				X
5- Portugal in the EU context		X	X	X		X	X				X
6- Mapping European cities (ArcView3 exercise)			X	X		X	X				
7- Portuguese typical foods		X	X	X		X	X				
8- Portugal's physical geography			X	X		X	X	X	X	X	

Figure 2 – Learning experiences according to spatial analysis skills.

Defining and selecting learning experiences met a set of criteria, such as:

- They should explore problems and issues that are significant to the curricula, but also the community reality.
- They should emphasize the importance of geographic information in different activities and in different subjects.
- They should use different technologies to collect, process, view and analyze spatial information.
- They should promote the use of GIT in different learning contexts (classroom, field trips, homework...).
- They should work at different scales (local, regional, European and worldwide).
- They should include tasks that promote multidisciplinary activities and promote different spatial analysis skills.

Creating a learning experience requires defining criteria that are put on a form in ConTIG's website (Figure 3).



Figure 3 – ConTIG's website

These criteria are: defining the subjects involved, the *curricula* contents, scale, equipment and resources that will be necessary, type of competence analysis intended to promote, and the results that are expected (like a report, a map, a poster, a flyer...). After the creation of a learning experience, it can be changed,

updated and edited online. It's also possible to upload materials such as tutorials, guidelines for teachers and students, images, geographic data, assignments and the results made by the students. This way, both students and teacher will always have available the necessary materials to implement the experience. The creation of a WebGIS tool will allow data editing and visualization in order to undertake analysis and processing collected or produced information (Figure 4).

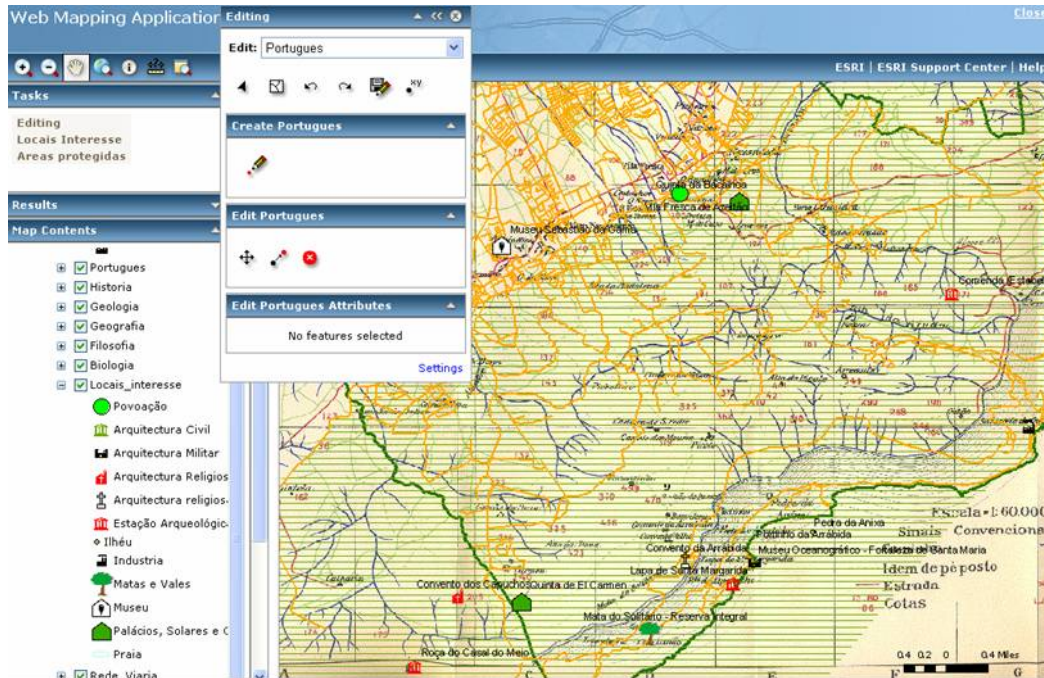


Figure 4 – ConTIG's WebGIS tool

With everything online, we aim to share the work, data, ideas, maps and results, disseminating the project and all the materials produced.

3. DEVELOPED ACTIVITIES

During 2007/2008 school year, ConTIG carried out some activities with students and teachers. The year started mainly with meetings and workshops to outline the project and the activities, to determine which subjects and classes were to participate and also to give some basic training to teachers. At this first phase, some of the above mentioned support materials were produced.

3.1- GIS-Day 2007 at ISEGI-UNL

The first activity held with students consisted of a GIS-Day, on November 2007. ISEGI-UNL had organized GIS-Days for several years and one of the teachers involved in the project had also organized two previous GIS-Days. This year, students and teachers of both partner schools participated in the event held in ISEGI-UNL campus. The program of the day consisted in a brief reception and presentation of GIS theoretical concepts. Then, students participated in a Geo-paper in which they had to find some places in ISEGI-UNL's campus. To find these places they had to follow some clues and use PDA's with GPS (Figure 5). They had to finish all the clues and go to all the places in the shortest time period possible.



Figure 5 (a e b) –Geo-paper activity during 2007 GIS-Day at ISEGI-UNL

The day ended with a complimentary snack, the announcement of the results, the award distribution for the winning teams and participating certificates and gifts for all.

3.2- Classroom activities

During the school year, the teachers started to develop activities for the classroom. Some teachers involved in the project, teaching in other schools (Palmela's Secondary School and Geographical Sciences Professional School) also developed activities with their students. Despite the fact that only two schools are registered partners of ConTIG, there are now four schools that are benefiting from the project.

In Palmela's Secondary School, 7th grade students developed projects in Geography classes and also in Project¹ classes. They developed several projects in which they produced maps and researches about tectonic plates, the location of volcanoes, Portugal's location, where they live and how far they live from their school, etc. These projects were part of an exhibit at school. Two of these 12 year old students, with some help from their teacher, made a poster that was presented at ESRI-Portugal User Conference (Lisbon, March 2008) [4]. Other students participated in a contest called My Map, promoted by the Department of Geography of Porto's University [5].

Students of the Geographical Sciences Professional School also developed projects and submitted a paper that was presented at ESIG08 [6]. This project consisted on a study about sustainable development in Portugal and they used ArcGIS software to analyze different kind of data.

3.3- Field trip to Arrábida Natural Park – one of the learning experiences

One of the learning experiences was developed in Pinhal Novo's Secondary School and consisted on a field trip to Arrábida's Natural Park. This is a park located not too far from Lisbon (to the South) and very near Pinhal Novo. This was probably the biggest learning experience of the project so far because it involved several subjects and several levels of students. It covered different analysis scales and worked with a variety of skills (such as data acquisition, visualization, cartographic representation, analysis tools, reprocessing, among others). This experience was carried out very successfully. The visit was organized by Geography, Biology, Geology, Philosophy and Computer teachers

¹ In Portugal there are some non disciplinary classes that are mandatory, such as Project, Tutoring Studies and Citizenship

from different levels (11th grade, 9th grade and also professional courses on gardening and tourism technician). They visited an important local geological formation, explored the vegetation, located restaurants and hotels, and visited a convent. They observed rocks and plants took pictures, registered geographic coordinates (figure 6).



Figure 6 (a e b) – Field trip to Arrábida – Pinhal Novo Secondary School

Due to the success of this visit, they made a second one, inviting teachers and students of Maria Amália Vaz de Carvalho Secondary School (ESMAVC) to accompany them. In return, there was a third visit where Pinhal Novo's teachers and students went to visit the water museum in Lisbon, with teachers and students of ESMAVC.

4. FUTURE PROJECTS

Given the positive results and the potential of this project, we hope to continue to work with the learning experiences already established. Even after the official period of the project is over, it is expected that the teachers involved in creating learning experiences continue to use them and adopt these teaching methods in their classrooms. Contacts made informally with teachers from other schools, have demonstrated that the project is valid and there are schools that are interested in developing similar activities. To ensure the maintenance of an Internet platform that supports the materials and the WebGIS tool, it would be essential to benefit from other types of financing in order to maintain and develop the project. The ConTIG website is a database of ideas, activities,

geographical information, etc. It would be interesting that the development of this project would allow other schools to join the project, and we could establish a community of users sharing data, materials and ideas freely without any restrictions. Our intention is to disseminate the project in meetings, in teacher's seminars and by any means at our disposal.

5. REFERENCES

- [1] MOTA, Madalena; 2005, "Concepção de *curricula* em análise espacial para o terceiro ciclo do ensino básico", Master thesis in Geographic Information Systems & Science, ISEGI - UNLisbon, (URL: <http://www.isegi.unl.pt/servicos/documentos/TSIG007.pdf>).
- [2] MOTA, Madalena; PEIXOTO, Miguel; PAINHO, Marco; CURVELO, Paula; FERREIRA, Francisco M., (2006), *ConSIG - Using GIS in teaching/learning processes* "26th Annual ESRI International User Conference", August 7th to 11th 2006, San Diego Convention Center, California, USA. (Paper N.º. UC2042, http://www.isegi.unl.pt/labnt/papers/ESRI_2006_p2042.pdf).
- [3] MINISTÉRIO DA EDUCAÇÃO, 2001, *Currículo nacional do ensino básico: competências essenciais*, (Lisbon: Ministério da Educação – Departamento da Educação Básica).
- [4] MOTA, Madalena; PEDROSO, Rodrigo; MARQUES, Bruno, 2008, *Distribuição espacial das residências dos alunos do 7.ºC da Escola Secundária de Palmela*, Poster presented at ESRI-Portugal User Conference (EUE08), March 26th and 27th, Lisbon.
- [5] Contest *O meu mapa* (URL: <http://omeumapa.blogspot.com>).
- [6] CONCEIÇÃO, Alexandre; MATOLA, Hermínia; MEDEIROS, Emanuel; MENDES, Tiago; OLIVEIRA, Rafael, *Análise do Desenvolvimento Sustentável em Portugal – Uma abordagem SIG proposta pelos alunos da EPCG*, ESIG 2008.