

# ConSIG - Using GIS in teaching/learning processes

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## Abstract

In order to encourage the use of experiments in learning science, the Institute for Statistics and Information Management of the Universidade Nova de Lisboa is developing, together with *Maria Amália Vaz de Carvalho* Secondary School and *Pinhal Novo* Secondary School, a project aiming to promote the experimental teaching of sciences based on the use of Geographical Information Systems (GIS) in different curricular areas, where the spatial dimension provides a privileged context for the establishment of analysis and exploration frameworks. For this purpose a group of activities focused on the production of scientific contents for GIS use in elementary and secondary education is proposed. This project will create the information infrastructure and an Internet Portal where teachers and students can access WebGIS tools and contents with a view to an exchange of knowledge and resources.

## 1. Introduction

The ConSIG project aims to promote experimental learning experiences in middle and secondary school students in Portugal, applying new teaching methods and using information technologies, particularly GIS. This will all be done accordingly with the Portuguese *curricula* orientations for middle and secondary school. Through the concepts and principles of one discipline, this project will lead students to find solutions to everyday problems through research activities, where space is the common element of different knowledge's, as it is the stage of multiple relationships between natural and human phenomena.

## 2. Scope and Objectives

The ConSIG project – “Using GIS in teaching”, is supervised by ISEGI-UNL, in partnership with two secondary schools (*Secundária de Pinhal Novo* and *Maria Amália Vaz de Carvalho*).

The central aim of this project is to promote experimental methods of teaching sciences, particularly Geography, through methods supported by the use of GIS. Because the spatial dimension is present in different areas, it is intended for these methods to be used not only in Geography classes, but also in others disciplines and non disciplinary classes (such as Tutored Study, Project or Civic Education). The spatial dimension will be the common element that tends to be the context that establishes a scenario for analysis and exploration of different phenomena. To do this, some activities are being planned to produce materials that will lead to the use of GIS in middle and secondary school. Some of these activities and materials include information texts and exercises, instruction manuals for the use of GIS programs in the class room and in field work, an information infrastructure to support different projects as well as publication and diffusion of these results and materials to the teaching and scientific communities. This project will also produce a web site where teachers and students can find: geographic information, examples of ways to approach a specific subject in class (for different disciplines and different grades), *WebGIS* tools that make possible to manage geographic information and spatial analysis in different contexts. All the materials available will be the result of the collaboration between ISEGI's team and the teachers of both secondary schools. These materials will be tested in class with the students of these two schools.

Through this initiative we aim to equip both secondary schools with tools that will help organize and manage classes, according to the orientation principles of the national *curricula*, which "values diversity of teaching methods and learning activities, particularly using communication and information technologies, leading to skill development on a perspective of life long learning".

### **3. The Proposed Approach**

The study of territorial scenarios through spatial analysis processes may be a methodology to break away from the thematic logic that underlies middle school Geography *curricula* in Portugal. The *curricula* can be organized based on spatial analysis concepts, which may further be adapted to all geographical themes. Teachers usually tend to follow the thematic order in which the *curricula* is organized. We propose an approach to the geography *curricula* centered on skills instead of themes (Fig. 1).

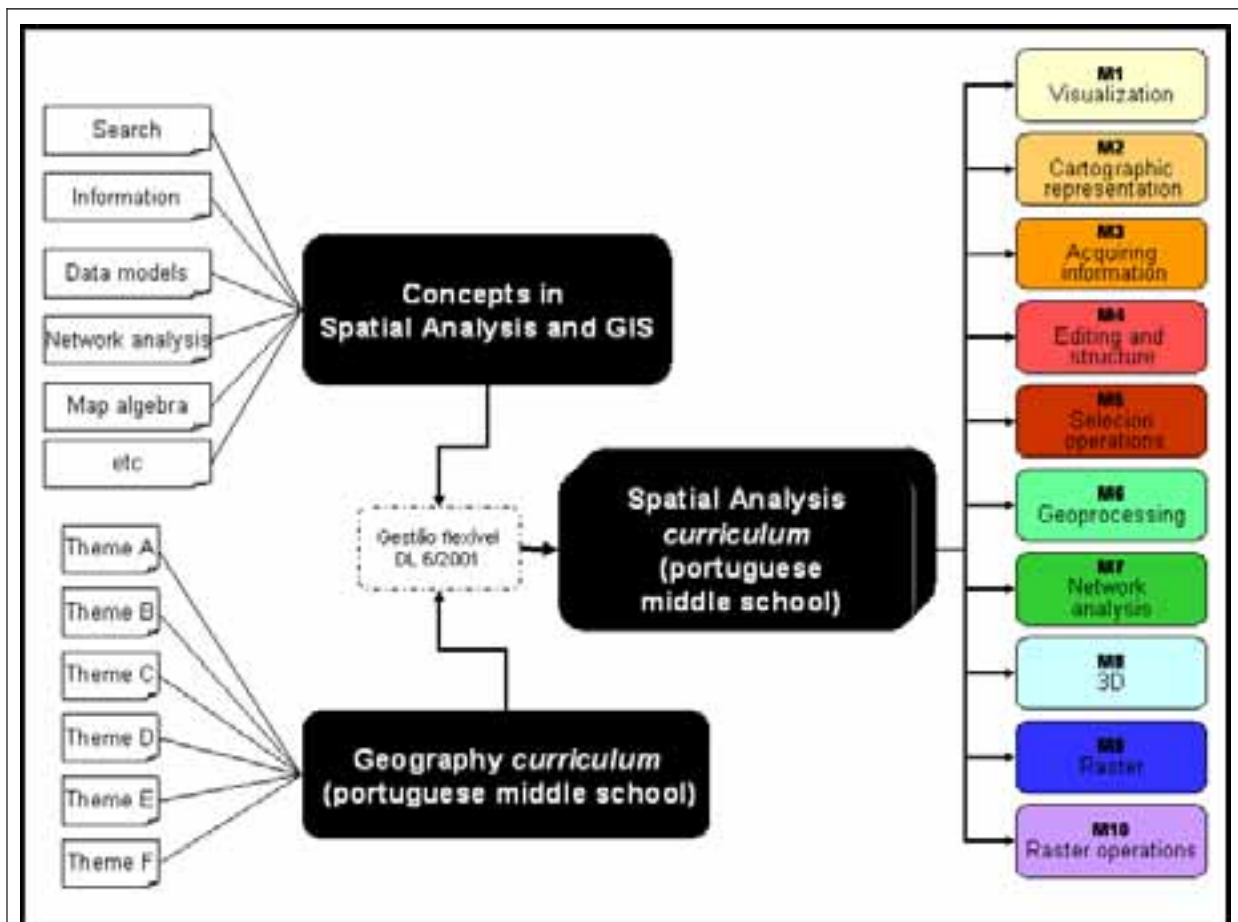


Fig. 1 – Transforming the Portuguese Geography *curriculum* in a Spatial Analysis *curriculum*, organizing it by concepts in spatial and analysis GIS. Themes: A - The earth: studies and representations; B - Natural environment; C - Demography; D - Economic activities; E - Development contrasts; F - Environmental issues, (Adapted from MOTA, 2005)

In 2002 there was a new organization of the Portuguese curricula for middle school (DECRETO-LEI n.º 6/2001). According to this organization, which allows some flexibility on managing the Geography *curriculum*, we would like to propose that GIS be used on different disciplines to teach Geography or other subjects. Spatial thinking is present in different areas because most phenomena take place in place and have some kind of spatial distribution. Geography is one of the most multidisciplinary and transverse sciences and is also one of the disciplines with biggest potential in the formation of youngsters (CACHINHO, 2005). The Portuguese ministry of Education considers Geography as a link between social and natural sciences (MINISTÉRIO DA EDUCAÇÃO, 2001a). They recognize the importance of spatial thinking to understand the relationship between spatial phenomena.

The new *curricula* (DECRETO-LEI n.º 6/2001), was conceived based on principle of diversification, flexibility, articulation and multidisciplinary. Teachers must use multiple and diverse methods and materials in their classes. They should generate different learning experiences to include different

kinds of students. They also should include information and communication technologies. This *curriculum* lists several standard skills a student must acquire when finishing 9<sup>th</sup> grade (MINISTÉRIO DA EDUCAÇÃO, 2001a). There are also specific skills in each discipline that must be experienced in conjunction with the standard skills. So, the process of learning must be seen as a whole common project involving students and all the teachers.

Pedagogic attitudes must orient students to build their own knowledge (the constructivism, project based learning and inquiry theories as referenced by JARRET, 1997) through experiences and the use of communication and information technologies. These technologies (in which GIS are included) can make Geography a more stimulating subject. (CACHINHO, 2005).

To really be learning according to the inquiry theory, students must be able to ask questions in a way that they can investigate what they are studying: formulate hypothesis, plan an investigation, gather data, analyze data, make conclusions and present those conclusions. It's been verified that this kind of teaching gets better school results and promotes positive attitudes toward science (JARRET, 1997). Baker (2002) defends that project based learning and inquiry help students having a better and more general sense of the world instead of trying to define an isolated and objective reality. Knowledge evolves through social and cultural interactions. In a constructivism context, knowledge is a result of a dynamic social process (BAKER, 2002). According to Malone *et al*, this mode of thinking is not unlike other research-oriented approaches, such as the scientific method, with a big difference: space. Knowing where something is, how its location influences its characteristics are the foundation of geographic thinking (MALONE *et al*, 2002).

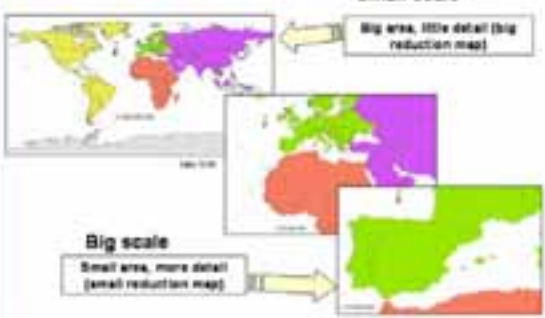
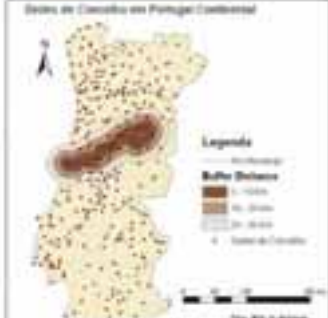
The aim of this project is to have students develop skills that allow them to interpret and manipulate geographic information. Spatial analysis in a GIS environment is a helpful tool that can also promote interdisciplinarity, one that can be used in nondisciplinary classes.

Here are some examples (fig. 2, 3, 4 and 5) of how to teach about spatial analysis concepts using GIS:



Fig.2 – Example on module one: visualization

Fig.3 – Example on module one: visualization

<p><b>Cartographic representation:</b>  <small>«Different scale maps»</small></p> <p><b>Small scale</b>      Big area, little detail (big reduction map)</p>  <p><b>Big scale</b>      Small area, more detail (small reduction map)</p>	<p><b>Selection operations:</b>  <small>«Distance operations in several layers Buffering»</small></p> <p><b>BUFFER</b>      An area around an element within a pre-define distance</p> <p>In this example it's possible to identify cities that are at a distance of 10, 20 and 30Km from the Mondego river (in Portugal)</p> 
<p>Fig.4 – Example on module two: cartographic representation</p>	<p>Fig.5 – Example on module five: selection operations</p>

(Adapted from Mota, 2005)

#### 4. The GIS Day Initiative

Both secondary schools involved in this project joined, in 2005, the GIS-Day activities with the following goals:

- » Develop, in the students, spatial analysis skills, a critic sense on spatial management and consolidate research and group work techniques;
- » Make maps for further studies;
- » Make students aware of the importance of geographic information on everyday activities and on spatial management.

On the day of the event, November 16th 2005, some activities took place, both in ISEGI and in Pinhal Novo's secondary School, like:

- » Opening sessions with a lecture on GIS concepts and uses;
- » Field work with GPS and maps on paper to locate different things in the school yard (like flower-boxes and the Gym Pavilion) (fig. 6 and 7);
- » Demonstrations and experimenting (by students) of ESRI software;
- » Exploration on internet sites (like Google earth), searching for geographic information (fig.8);
- » Building a census with the location of students homes, so we have a georeferenced database of the students (fig.9);



Fig.6 – Connecting the GPS with the computer



Fig.7 – Locating flower boxes in the school yard



Fig.8 – Exploring internet sites looking for geographic information



Fig.9 – Building a census, locating students homes in ArcMap

You can see what happened here:

- » [http://gis2.esri.com/gisday/successstory\\_search1.cfm?eventID=7494](http://gis2.esri.com/gisday/successstory_search1.cfm?eventID=7494)
- » <http://clientes.netvisao.pt/mgalvaod/gisday.html>
- » [http://www.isegi.unl.pt/labnt/presentations/2005/Gis\\_Day2005.pdf](http://www.isegi.unl.pt/labnt/presentations/2005/Gis_Day2005.pdf)

These activities took place in collaboration with teachers from other universities (*Faculdade de Letras de Lisboa* and *Instituto Politécnico de Portalegre*) and also a technician from Palmela's Municipality that helped the pupils in practical activities. At the end of the day some students showed everyone what they did, explaining how they did the field work, how they used ArcMap, and how they located their homes in maps. They demonstrated interest and enthusiasm in these themes, showing that they enjoyed doing these activities. They looked motivated towards

Geography and Spatial Analysis and were very much at ease dealing with geographic information technologies.

## **5. Expected Results**

With this project we expect that students develop:

- » Motivation and encouragement;
- » Cooperation and group work skills;
- » Perception for the vast complexity of the world;
- » Skills for comprehension of Geography concepts like scale or projections;
- » Skills on spatial analysis in general and in problem analysis;
- » Geographic, spatial and computers literacy;
- » Skills on research techniques, gathering and organizing information;
- » Skills in mathematical, logical, linguistic and spatial ratiocination;
- » We also believe that working with GIS in schools will promote learning experiences that are linked with reality (we can study cases with real life data, maps of the regions where students live, etc.), but also using tools that some students will likely be using later on in their jobs.

Some experiences have been made with 7th, 8th, 9th and 12th grade students in Portugal with good results: not only were they motivated toward geography, but they also developed technology, relationship, and management information skills.

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## **References used in this article:**

BAKER, Thomas R., 2002, *The effects of GIS on students' attitudes, self-efficacy, and achievement in middle school science classrooms*, PhD Thesis, University of Kansas.

CACHINHO, Herculano, 2005, Formação e inovação na educação geográfica: os desafios da pós-modernidade. In *Actas do II Congresso Ibérico da Didáctica da Geografia* [CD-ROM] (Lisboa: Associação Portuguesa de Professores de Geografia e Asociación de Geógrafos Españoles, Grupo de Didáctica).

DECRETO-LEI n.º 6/2001. *D.R. I Série A*, **15 (18-01-2002)**, 258-265.

JARRET, Denise, 1997, *Inquiry strategies for science and mathematics learning: It's just good teaching* (Northwest Regional Educational Laboratory – US Department of Education) (URL: [www.nwrel.org/msec/book2pdf.pdf](http://www.nwrel.org/msec/book2pdf.pdf) consulted in November 25 2004).

MALONE, Lyn, PALMER, Anita, VOIGT, Christine, 2002, *Mapping our world: GIS lessons for educators* (Redlands: ESRI).

MINISTÉRIO DA EDUCAÇÃO, 2001a, *Currículo nacional do ensino básico: competências essenciais*, (Lisboa: Ministério da Educação – Departamento da Educação Básica).

MOTA, Madalena; 2005, "Concepção de *curricula* em análise espacial para o terceiro ciclo do ensino básico", MSc Dissertation in GIS&Sc, in

<http://www.isegi.unl.pt/instituto/servicos/sdoc/bdbiblio/documentos/tsig007.pdf>

#### **Other references:**

ALONSO, Luísa, 2000, A construção social do currículo: uma abordagem ecológica e prática. *Revista de Educação*, **Vol IX, 1**, 53-67.

AUDET, Richard e LUDWIG, Gail, 2000, *GIS in schools* (Redlands: ESRI).

BAKER, Thomas R., [acesso em 2004], *The History and Application of GIS in K-12 Education*, (URL: [www.gisdevelopment.net/education/papers/edpa0003.htm](http://www.gisdevelopment.net/education/papers/edpa0003.htm), consulted in January 10 2004).

BERTIN, Jacques, 1967, *Sémiologie graphique* (Paris: Mouton et Gauthier-Villars).

DESPACHO NORMATIVO n.º 1/2005. *D.R. I Série A*, **3 (05/01/2005)**, 71-76.

DESPACHO n.º 9590/99. *D.R. II Série*, **112 (14/05/1999)**, 7217-7219.

ESRI, 2005, *Gis Dictionary*, (URL: [www.esri.com](http://www.esri.com), consulted from 2003 to 2005).

ESRI, 2002, *Geography matters – an ESRI white paper*, (Redlands, ESRI).

GOODCHILD, Michael, 1998b, *The NCGIA GIS core curriculum for technical programs* (URL: [www.ncgia.ucsb.edu/education/curricula/ccpt/units](http://www.ncgia.ucsb.edu/education/curricula/ccpt/units), consulted in January 10 2004).

HEYWOOD, Ian, CORNELIUS, Sarah, CARVER, Steve, 2002, *An introduction to geographic information systems* (2ª ed.) (Harlow: Prentice Hall).

KANGIS, [2005], *K12 GIS community*, (URL: <http://kangis.org>, consulted from Novembro 2004 to March 2005).

KERSKY, Joseph, 2000, *The implementation and effectiveness of geographic information systems technology and methods in secondary education*. Dissertação de Doutoramento (PhD), University of Colorado at Boulder. (URL: <http://gis.esri.com/library/userconf/proc01/professional/papers/pap191/p191.htm> consulted in October 7 2004).

LEI N.º 30/2002. *D.R. I Série A*, **294 (20-12-2002)**, 7942-7951.

LEI N.º 46/86. *D.R. I Série*, **237 (10-10-1986)**, 3067-3081.

MINISTÉRIO DA EDUCAÇÃO, 2002, *Reorganização curricular do ensino básico: Novas áreas curriculares*, (Lisboa: Ministério da Educação – Departamento da Educação Básica).



- MITCHEL, Andy, 1999, *The ESRI guide to GIS analysis* (Redlands: ESRI).
- MONMONIER, Mark, 1996, *How to lie with maps* (2<sup>a</sup> ed.) (Chicago: The university of Chicago Press).
- MOTA, Madalena, 2005, Os SIG na escola, *Apogeo*, **27/28**, 12-17.
- NCGIA, 2000, *Core curriculum in GIScience* (URL: <http://www.ncgia.ucsb.edu/giscc>, consulted from 2003 to 2005).
- PALADINO, Steven, 1004, *A role geographic information systems in secondary schools: an assessment of current status and future possibilities*. Tese de Mestrado (Masters), NCGIA, University of California, Santa Barbara. (URL: <http://www.ncgia.ucsb.edu/~spalladi/thesis/title.html>, consulted in October 8 2004).
- ROBINSON, Arthur, SALE, Randal, MORRISON, Joel, MUEHRCKE, Philip, 1984, *Elements of cartography* (5<sup>a</sup> ed.) (N.York: John Wiley and sons).
- US DEPARTMENT OF EDUCATION, 1998, *Goals 2000 : reforming education to improve student achievement*, (URL: [www.ed.gov/pubs/G2KReforming/g2intro.html](http://www.ed.gov/pubs/G2KReforming/g2intro.html) e [www.ed.gov/pubs/G2KReforming/g2ch1.html](http://www.ed.gov/pubs/G2KReforming/g2ch1.html), consulted in March 30 2004).

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