

# Proposal of a Semi-autonomous Workshop to Learn GIS in Geosciences

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## Abstract

For the last 10 years, geoscience professions have been changing their practices including new technologies and new proficiencies of geomatic sciences. As a consequence, geological skills and knowledge required by the labour market today evolve but, paradoxically, geosciences in France's higher education curriculums do not seem to answer these new needs. Our proposal is a learning system whose main goal is to facilitate the spread of GIS learning. In this paper we introduce how the learning system has been set up and assessed. The first step consisted in an overview of the evolution of professional practices, and an analysis of pedagogical practices deployed in GIS university courses in Geosciences. This phase was followed by the setup of the learning system. An experimental process was also carried out with groups of students. The preliminary results are presented here.

This project is led by Joseph Fourier University along with Esri France, the Laboratory of Informatics of Grenoble, and the "Observatoire des Sciences de l'Univers de Grenoble".

## 1 Introduction

The progress of GIS in geosciences is now undeniable, neither from the standpoint of professional activities, nor the point of view of required competences (RAAB & FRODEMAN 2002, VARET 2008).

Many computer developments in the field of geosciences, among which we find « geo-referenced » databases, global positioning systems, 3D visualisation, are quintessentially linked to the use of GIS. It clearly appears that the acquisition of GIS know-how must be handled by a learning system. After an examination of the contents of Master Degree programs available in 35 higher education institutions and schools in France, we noticed that GIS classes are not always present in the syllabus. If such classes are present, they occur at the end of the curriculum and take the form of an initiation with a limited amount of time.

Analysis of pedagogical practices deployed in GIS university courses in geosciences show that professors manage their programs in a fairly autonomous manner. If the teacher is a computer scientist or geomatician, his/her teaching is technical and lacks context: the emphasis is on the software functionalities. Conversely, if he/she is more of a thematic expert, the emphasis will be on usefulness of GIS for solving problems and the functional aspect will be neglected. This situation can cause significant problems in terms of interoperability of the data, their treatment, and the pooling of resources.

With the goal of addressing these needs, we built a semi-autonomous learning system online, the « GIS-Geosciences Workshop » which has three main objectives:

- Developing technical competences to master some functionalities of GIS (i.e. data management, geodatabases, analysis tools)
- Reinforcing methodological skills in spatial analysis (SMITH et al. 2006) (i.e. query and multi criteria evaluation)
- Managing a project by using a GIS in a professional environment (set up a suitability study of a zone by using the new technologies).

Yet, this system should offer opportunities of exploitation of these techniques for various case studies. It should encourage students to participate in the construction of their portfolio of skills (GOODCHILD & KEMP 1990), and stimulate their involvement and autonomy.

## 2 The Learning System

The development of the workshop, in terms of educational scenario and pedagogy, autonomy and management of the workload, relies on the notion of scenario developed by the research field in technology enhanced learning on one hand, and on concepts of educational approaches based on problem based learning on the other. A scenario is an ordered set of activities, governed by actors who use and produce resources (PAQUETTE 2002). In the case of our workshop we decided to rely on the knowledge/competence model among other educational approaches. G. PAQUETTE (2002) underlines how important it is to be able to identify, explain, represent, and design knowledge prior to any educational approaches: in educational engineering, the first question which comes to mind is: what sort of competences should students acquire?

The type of learning process is “active” and centered on problem solving. LEBRUN & BERTHELOT (1994) define this as “the systematic study of hypothetical or genuine problem situations – which leads to assessing the nature of the problem, analyzing the data, and deciding which principles and concepts to use to offer a workable solution.”

### 2.1 Learning objectives, scenario and tools

In order to acquire and use specific competences, students are asked to work in genuine professional situations. This learning approach corresponds to current educational practices that favor authentic learning (SIMON 1962). Students must carry out a suitability study and define the potential sites for a vineyard within a given area (JONES 2004). This scenario combines an approach modeled on scientific inquiry (SANCHEZ 2008) and methods and tools for multicriteria spatial analysis (MALCZEWSKI 2004), such as surface analysis calculations (determine optimum slope, aspect and elevation), reclass data and suitability models. To carry out their study, students follow a learning pathway that was divided into six phases and articulated with educational resources and a tutorial.

To help students complete each phase, a collection of seven worksheets is available: they contain preparatory exercises (tables to complete, questionnaires ...) to help students accomplish the tasks required in each phase. Also available are seven support folders designed to introduce basic geomatic notions and to guide students in the use of the software. The tutorial is organized in five classroom teaching sessions, each lasting two hours, and an email-based follow-up that allows students to address the tutor when the need arises. The five classroom sessions are devoted to presenting the workshop and the digital work envi-

ronment (1), presenting the requisite methods and techniques to resolve the given problem (3), and collecting the students' work (1). Students organize their work in distance learning, respecting the activities' deadlines. Table 1 presents the architecture of the course and the skills targeted in each phase.

**Table 1:** Course architecture

Structure	Contents	Geological Skills	GIS Skills	Teaching aid	
Introduction	Explaining the context and how the workshop will carry out	Appropriate problem's criteria		Activity : Write a statement of work: specify the processes involved to solve the spatial problem (ws) <sup>[1]</sup>	Material en resources on « vineyard »
Step 1	Searching and collecting data	Observe and analyze the soil	Manage and visualize data	Activities : 1. Parameters (ws) 2. Nature of data (ws) 3. Data files (ws)	Support folder : 1. Geographic data types and formats
Step 2	The data management		Create a database with spatial reference	Activities: 1. Spatial reference Systems (ws) 2. A file database	Support folders : 2. Spatial reference Systems 3. ARCGIS database
Step 3	Geoprocessing	Transpose geological tasks to computing tasks	Familiarise with the main surface analysis tools	Activities: 1. The main functions to know 2. How to choose the functions (ws)	Support folders : 4. Working with raster data set 5. Surface and Spatial Analysis tools
Step 4	Overlay analysis and suitability models	Represent an analysis process	How to combine different layers	Activities: 1. Process and weighting (ws) 2. Create a graphic model	Support folder : 6. Model Builder
Step 5	The survey report	Write out an expert's report	Add a decision-making map in a report	Activities: 1. The final report 2. Take a decision	Support folder : 7. Saving, exporting and loading a map

[1] ws= worksheet

Two different tools were employed: (i) an educational online platform (DOKEOS) which enables teachers to create, organize, observe and supervise learning activities; (ii) GIS and Arc GIS software 9.3.1 to manage the database, calculations of surface and mapping.

## 2.2 Participants and method

The GIS-Geosciences Workshop has been proposed to Master degree students whose job opportunities are in small or medium size companies. They were divided into small groups of 2 or 3 people supported by a tutor. Students were 22-24 years old. Among the participants there was one disabled student with very low mobility. She benefits from this workshop since it allowed her to make a territorial diagnosis without moving to the field.

In order to assess the benefits of the GIS approach we set up a research protocol which consisted in identifying the knowledge of students about GIS at the outset and then at the end of their learning process. Their productions were analysed in order to identify their drawbacks in terms of theoretical knowledge. Furthermore, we conducted two interviews (before and after the workshop) to analyse students' vision and ability to use GIS.

## 2.3 First results

Students' productions proved that their level of competence in GIS use was very low: they showed gaps in the knowledge of data format, in the difference between feature data and raster data set or between a datum and a geographic projection. They also didn't know how to manage a project from the analytical approaches to the technical solutions. An analysis of interviews shed light on the evolution of mainly three competences, as Table 2 synthesizes:

**Table 2:** Synthesis of the evolution of the 3 core skills taken from interviews

Skills Observed	
<b>1. Structure and Management of territorial diagnosis</b>	
<b>Before workshop</b>	In the entrance interviews, all the students were questioned about the way in which they apply their expertise in identifying the most appropriate sites in Isere for developing a vineyard. We found that, most of the time, the procedure was not clear and they didn't know how to built concretely the survey (notably with regards to the data, their use and treatment, the cartographic report, ...)
<b>After workshop</b>	In the exit interviews, we asked the students which method of spatial analysis they would adopt to identify the best sites in Isere to install a ski resort. All were able to formulate a clear and logical procedure that took into account data research and integration, appropriate geoprocessing, and mapping.
<b>2. Setup &amp; application of the technical and analytical potentialities enabled by the tool</b>	
<b>Before workshop</b>	In formulating the contractual specifications, the students are unable to specify the treatment or functions needed for the surface calculations or for combining the desired indicators. They do not know how to search for data nor how to use them.
<b>After workshop</b>	All the students realized the essential role played by GIS in the interoperability of the data and in rapid data treatment. According to the students, GIS enables terrain studies to be done faster and more precisely.
<b>3. Appropriation and integration of the tool in professional life</b>	
<b>Before workshop</b>	The idea that the students have of a GIS is linked essentially to its visual character without considering its potential for calculating and spatial processing. Because of a lack of knowledge, they are unable to position a GIS in the sequence of steps of a territorial diagnosis. They do not see how the GIS can help in the decision-making process.
<b>After workshop</b>	They have overcome the « technological barriers » that a GIS can present and they feel more at ease with the use of this tool in professional domain. They know when integrate this tool in managing a project.

## 3 Conclusions

We consider this first work as a preliminary phase of exploration, which currently allows us, in a research work, to address two new goals: (i) to identify and evaluate essential geomatic skills for young geologists (MANDUCA 2002) through a learning system increasingly

close to professional reality; (ii) to carry out a research protocol in order to study the impact on the reasoning of multi-criteria evaluation for suitability soil analysis.

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