

## Designing and teaching GIS courses for planners in Greece

Vassilis Pappas  
Assistant Professor,  
Laboratory of Urban and Regional Planning,  
Department of Architecture, School of Engineering,  
University of Patras, Rio, Patras, Greece, 26500  
vpappas@upatras.gr



### Abstract

The paper examines the parameters and factors that affect the core curriculum and didactic methodology of the "Geographic Information Systems" course as taught, by the author, at various University Departments, across Greece, for almost twenty years. The methodological assumptions pertaining the course are presented through a comparative approach on the grounds of the experience gained from teaching Geographic Information Systems during the recent semesters, the previous experience and practice acquired by the author as well as on the basis of international didactic paradigms with regard to teaching the subject to academic students, focused on Urban and Regional Planning.

Probing of the specific thematic issue demands a considerable of inter-disciplinary knowledge that is only possible through a collective - cooperative effort of specialized scientists-technicians. The effect of this ascertainment in regard to the definition of the didactic method employed and the content of the GIS course is made apparent through the following question: "Is the teaching of GIS technology possible if stripped completely of its thematic context of application?"

On the grounds of this question, securing the academic level of the didactic method in the scientific field of GIS emerges as a major issue, a fact which is opposed to specialization with respect to a particular applications and especially in regard to its dependence on a specific software (education v. training). Moreover, securing the level of the didactic methodology employed implies the risk of other relevant sciences interfering with the object of study on the grounds of the definition of GIS technology as an inter-scientific process.

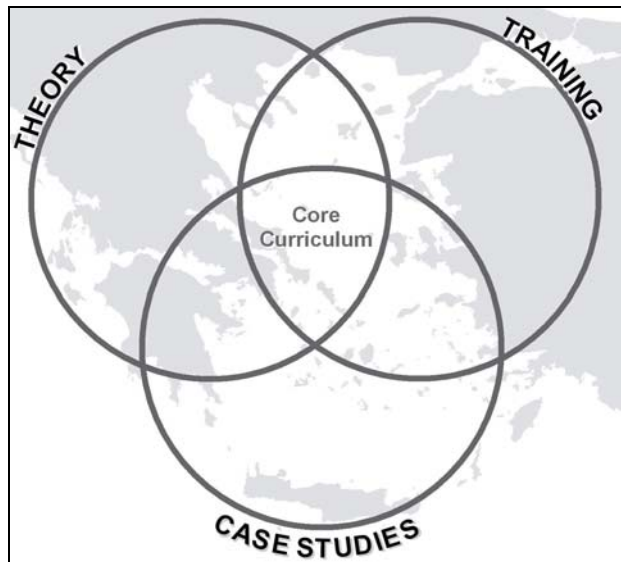
### Introduction

The author has a longtime experience, since 1986, in teaching "Geographic Information Systems" courses for planners, in various academic departments<sup>1</sup>. Mainly these courses are taught in the 5th to 7th semester of studies and the majority of them are focused on Urban and Regional Planning case studies. Additionally the author had the last semester the responsibility of designing and teaching a GIS course in a Department of Archeology and the comparison of the courses' structure and the different methodological assumptions arose the present syllogism.

In general, the applied course curricula have the same structure and encompass an introduction to the theory and the basic principles of Geographic Information Systems, suggestions for tackling methodological issues, a reference to modern scientific developments on the field as well as practical exercises for the development of pilot applications. The teaching curriculum consists of a cycle of lectures (on theory) and laboratory exercises, and is further completed with a "hands on" presentation - substantiated support of the exercises including a written examination. In summarizing, the environment of the educational process has been designed as illustrated in the following diagram (fig. 1) whereas, in particular, the range of issues that are discussed includes the following:

*Introduction. Basic concepts. The information process. The computer environment. Introduction to Databases. G.I.S.: Classes, Features, Coordinates, Content. Structures of digital cartographic data. Digital maps and the concept of Topology. Spatial data management. Design of databases, Data Acquisition, Organization, Codification, Digitalization. Error modeling and topology structure. Map algebra. Data processing. Production of thematic outputs. Indicative thematic case studies (applications). G.I.S.: Managerial application problems.*

<sup>1</sup> Such as: Civil Engineering Department, Department of Planning and Regional Development, Department of Architecture, Department of Archeology, etc.



1. Educational context

The exercises' range of issues varies from year to year and from Department to Department. The central issue, during the last two semesters, concerned the team work for the development of a Geographic Information System for the Periphery of Western Greece (initial digitalization scale 1:200,000, map supplied by the Ministry of Environment, Physical Planning and Public Works). Each group of students (consisting of 1 or 2 persons) was assigned a specific part of the overall implementation procedure of the project, mainly focused in the database development and in Spatial planning paradigms.

In abstract, the consolidation of the basic principles of the Geographic Information Systems' technology through

the cycle of lectures and primarily through the elaboration of exercises has been the main focus of interest with respect to the educational process and in the thematic orientation of the Department, which usually accomplished successfully. Furthermore, the implementation of the educational goal has been attributed, past other factors, due to the high percentage of attendance and the great interest expressed on behalf of the students.

### ***Crucial factors***

From the above brief presentation of the courses' content, it becomes obvious that not all topics are covered in regard to the range of issues of the field. This has been a result of speculation on behalf of the person responsible of the educational process taking into consideration the students' academic level of competence, the teaching hours available and the different levels of students skills (Czeranka M., Ehlers M., 1994). Thus, the course is didactically oriented towards an in-depth approach of certain issues than a linear exposition of a wider number of topics.

The specification of the above choices has been and is still characterized as an especially responsible and multi-parametric process and, as is evident, apart from the in-depth knowledge approach of the course's special field of study, the international experience and the market's demands have been also considered in addition to the occupational guidance of each Department's students seen as qualified graduates in the future so that the following issues' proper approach and analysis to be achieved:

- ✓ A. The teaching curriculum of the course and in particular:
  - A1. the level of theoretical close examination and approach,
  - A2. the number of topics exposed
  - A3. the connection of the course's core curriculum with the needs of the Greek reality,
  - A4. the content of the application examples presented,
- ✓ B. The teaching method of the course
- ✓ C. The nature and the content of the practical exercises as well as the type of application concerned, and
- ✓ D. The selection of equipment (hardware and software) employed.

More specifically, the level of theoretical close examination and approach (A.1) has been defined according to the general principles which govern the core curriculum of the National Center for Geographic Information and Analysis (NCGIA), as were initially described (Goodchild M., Kemp K., 1990) and updated (<http://www.ncgia.ucsb.edu/pubs/core.html>).

These general principles are the following: a) knowledge systematization b) exposition of the basic principles c) an attempt to present as many as possible topics ("a bit of everything") be it against to the required analysis, and d) an attempt to avoid the dependence from the particular software employed. A deviation has been made in regard to the third principle where the preference has been rather the in-depth

analysis of certain issues (such as topology structure and databases design) than the presentation of more topics resulting from the speculation on the best way to exploit the limited teaching hours available.

In addition, as regards to theoretical approach and practical exercises, significant weight has been assigned to eliminating the dependence from a particular software, even though only one specific software has been finally employed due to the limited budget available across all Departments.

The selection of the operational system, but and the application software, has been defined by financial criteria in combination to the already existing hardware installed. However, this had consequences of minor significance given the fact that the questioning regarding the selection of software tends to disappear to the extent that the possibilities offered by the existing software in relation to different operational platforms are almost identical, especially if this regards to the context of a certain educational process.

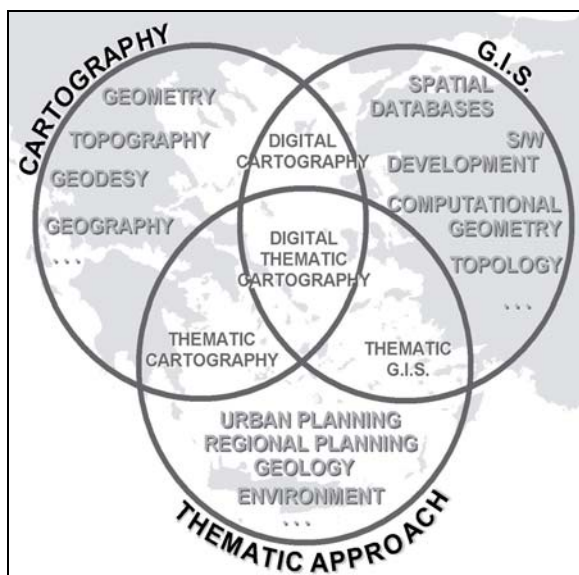
### *The scientific field's features*

Aiming to the definition and the analysis of the educational process and the didactic method employed, the specification of the essential features of the field is considered as crucial. The field's set of features is formed as follows:

- ✓ Inter-scientific process of technology application,
- ✓ Spatially dependent data (spatial databases),
- ✓ Par excellence applied issue,
- ✓ The classification methodology of the field's features is substantiated either in regard to the applications domain or in regard to the possibilities offered by the software available.

Furthermore, it is well substantiated and commonly accepted that the technology pertaining to Geographic Information Systems is an inter-scientific process with a wide range of applications (Polydorides N., 1993). The suggestive applications, at the WEB SITE of E.S.R.I. Company (<http://www.esri.com/industries.html>, last visit 31/5/2004), are "limited only by the imagination of those who use it" and it illustrates a range of thirty-seven different areas of GIS applications.

The previous remark serves as a starting point for the questioning regarding the definition of the didactic method employed for teaching Geographic Information Systems to academic students rather in relation



2. Educational content

to the field of applications than as a mere documentation of the range of applications of Geographic Information Systems in general.

In other words, GIS technology, being a par excellence applied subject, depends upon the specialization of the wider thematic field into the framework of which the course is taught (or the specific technology applied), whereas it demands essential and in-depth knowledge which is imposed and required by the sciences of informatics and of spatial planning in the wider sense of the terms (fig. 2).

Therefore, on an exemplary basis and with reference to the management and the planning of infrastructure network utilities within an urban environment, it is obvious that the use of the specific technology demands, past other things, an in-depth

knowledge of the theoretical and the practical tools of the particular thematic field of application which, in this instance, is schematically represented by the following key words: urban environment, networks, planning, management, informatics.

Thus, as inductively concluded, the exploration of the specific thematic issue demands a large volume of inter-scientific knowledge, which only through a collective effort of specialized scientists-technicians is possible to be accessed. The effect of this ascertainment in regard to the definition of the didactic

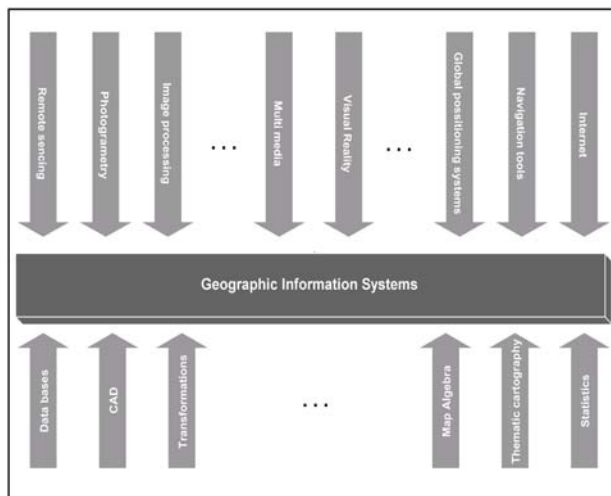
method employed and the content of the GIS course is made apparent through the following question: "Is the teaching of GIS technology possible if stripped of its thematic context of application whatsoever?"

**Restraints – Presuppositions - Requirements**

It is obvious that the answer to the above question is "NO" and this is because the Geographic Information Systems consist the main core of a specific technology, that is of a set of tools and methodologies for the acquisition, storing, retrieval, analysis, management and visualization of spatial information.

On the grounds of this answer, the securing of the academic level of the didactic method employed for the scientific field of GIS emerges as a major issue, a fact which is opposed to specialization with respect to a particular application and especially in regard to its dependence from a specific software (education v. training). Moreover, the securing of the level of didactic methodology employed implies the risk of other relevant sciences interfering with the object of study on the grounds of the aforementioned definition of GIS technology as an inter-scientific process.

In particular, the securing of the educational level can be accomplished with the lining up and the in-



3. GIS issues

depth tackling of theoretical issues pertaining to analytical-computational geometry, topology, geodesy, cartography, spatial planning, databases design etc. These issues, according to a widely acknowledged assumption, are tackled by the relevant sciences and at the same time are essential components of GIS (fig. 3). However the primary field of knowledge of the latter consists of the combined use of tools and methodologies, which exploit and on which are founded aiming to the solution or the tackling of specific thematic questions/ issues.

In other words, the methodological use of GIS technology itself is that which postulates new rules and theoretical approaches always though in conjunction with the selected thematic object. This position results directly in the necessity of defining "a chain of subjects" (considered as prerequisite) targeting to their integration into GIS technology. As a minimum, as such prerequisite subjects the following may be noted: databases design and management, geodesy and cartography issues, and primarily the specialization courses related to the specific content of each application. Such examples, among others, could be the Elements of Urban Planning or Cadastre issues, to the extend that the first regards to Urban Planning Information Systems and the second to Land Information Systems.

In other words, the methodological use of GIS technology itself is that which postulates new rules and theoretical

Measure techniques	Common Applications
Data management	
Visualisation	
Modeling	Uncommon Applications
Simulation	
Planning	Not possible applications

4. GIS Demands - Potentialities

In addition to the above, for an integrated definition approach of the didactic methodology of GIS technology employed, it is purposeful to go back to the needs that contributed to the emergence of GIS which, at the same time, consist the potentialities offered by these systems. Thus, Jack Dangermond in his opening speech at the 7th European Congress of ARC/INFO Users in Athens<sup>2</sup> reported six thematic areas-fields of applications-needs of GIS that are illustrated, thought-out, in the figure 4.

The three first classes refer to the production of simple thematic or other outputs, consisting the most common applications within the total range of thematic topics. However they are essentially rather appli-

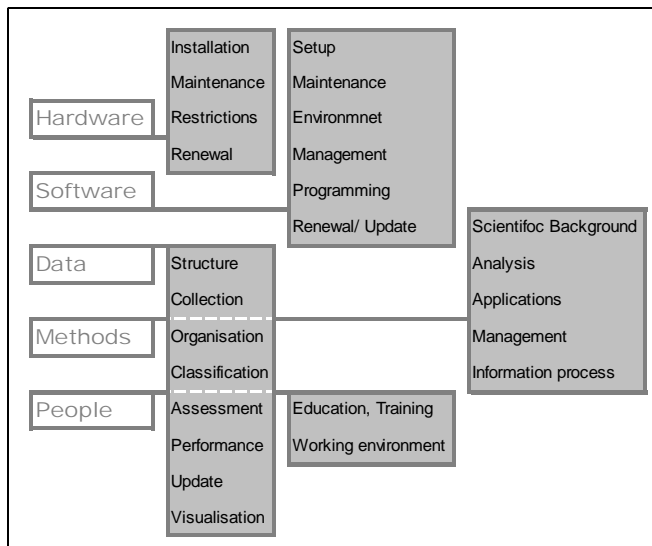
<sup>2</sup> According to the written notes of undersign author.

cations of automated cartography than applications that take advantage of the potentialities of Geographic Information Systems.

The next two are not very often met and they deal with the representation or function of spatial phenomena, either in real time or not, being a field of interest which is very cautiously now appearing in Greece. However, at this point it should be mentioned that the lately emerging DTMs (Digital terrain models) although their name denotes their incorporation into this class in fact they belong par excellence to the visualization class.

Finally, as regards to the latter, it has not been possible yet to be implemented in the prospect of yielding flexible and operational tools although a number of theoretical foundations have been laid. The concept of Planning implies the automated spatial phenomena planning process by calculation/estimation of effects or/and alternative scenarios. The development of tools pertaining to this class seems that it will be grounded on techniques and theories of Expert systems, Fuzzy Logic, Neural networks, ect. Given that, certain applications have already begun to appear however not incorporated into the planning class but mainly into the two previous ones (modeling and simulation).

It is obvious that the above possibilities - fields of knowledge lay the foundations for the theoretical background approach of Geographic Information Systems technology which in combination with the directions set by the following operational parameters of the environment of GIS technology (fig. 5) form the entire necessary theoretical approach and its didactic method.



5. GIS Operational parameters

The hardware and software employed depends chiefly on the wider development of information technologies although in some cases this is defined by the nature of the application itself (e.g. Satellite image analysis, orthophotomaps production etc.)

The data and methods are interdependent with the thematic object of application whereas targeting to build relationships between data (Dangermont J., 1989), as regards to the "People" parameter, the securing of continuous education and training becomes the major presupposition for safely defining an integrated educational process. This could be achieved through the establishment of post educational- training procedures, following the completion of graduate studies, being

directly oriented to the requirements of the market and the technological developments.

In conclusion, and always in relation to the defining of parameters which contribute to the didactic methodology of the course and the definition of the close examination of the field, it should be also mentioned the up-to-date Greek experience, a dominant feature of which has been the full dependence on the specific software and the downgrading of the object of knowledge to the training level and not the focusing on the theoretical thorough examination and education. A fact which has already been acknowledged and the first trends towards changing the content and the methods of teaching have emerged. This is considered as an especially difficult process which is however absolutely necessary for securing the level of educational process and the placing of GIS technology to the position that deserves.

### Conclusion - Proposals

As already substantiated, the definition of the didactic methodology regarding GIS technology mainly interdepends with its application issue and this primarily concerns a knowledge systematization process regarding the scientific fields involved which in its turn lays the foundations of new rules and methodologies.

The didactic methodology should be oriented to the nature of the field of knowledge within the academic division concerned and in this sense the selections of the thematic areas should be field-relevant.

For instance, within a Spatial Planning Department it seems that the most suitable practical exercises are those which refer to the analysis, planning and management of spatial phenomena than those which pertain to e.g. utilities and networks planning and monitoring applications which seem to be more suitable to Civil Engineering departments. Of course such an ascertainment has to do with the wider occupational guidance for the graduates of each academic division and especially with the vocational qualification of their field of interest. This is actually a rather crucial issue within the Greek society but abstracts from the framework of the present proposal.

Consequently, the didactic methodology of GIS, seen as a process oriented to the field of knowledge within the academic division concerned as well as suited to the needs required by the vocational area, should accept inputs from all factors which specify the scientific and vocational environment of its application and at the same time should demand special knowledge regarding each thematic area. The teaching of the relevant course under such terms is required to be incorporated into the last semesters of academic curricula in order that the students to have developed the necessary theoretical background, a critical view and the methodology of the thematic applications whereas they should have been taught preliminary issues such as databases, cartography etc. Under this view, any reasoning for the time availability has a valuable contribution for the duration of proper education process.

The educational process should be independent of a particular software and the emphasis should be focused on the systematization of knowledge and the development of methodologies and tools available and should be also supported by parallel educational processes (specialized training-close examination seminars by very apt professionals, with regard to the parameters which determine this area not excluding the trends suggested, the update for modern tools available, etc.) whereas special provision should be made for securing the continuous post-education of students and instructors. A procedure which is possible to be assigned to the academic divisions themselves and which has a lot to offer to the upgrading and the strengthening of their role within the scientific and professional grounds.

Furthermore, the introduction of continuous training processes is also especially valuable with respect to the "market's" demands with main factors being the scientific and professional experts who form its profile in order that the specification of the educational process meets the contemporary scientific and professional requirements.

Finally, a cooperation of the various scientific groups involved is required on an academic educational-research level so that the inter-scientific approach to be daily secured and new methodology tools and theories to be incorporated enriching thus the field of knowledge and the didactic methodology of GIS technology in order that the latter acquires the position it deserves without falling into the generally accepted mistakes of the past (i.e. education v. training).

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