GIScience Program Improvement through Innovative Curriculum Implementation Tools

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Abstract

Since 2002, the Institute for Statistics and Information Management of Lisbon offers an e-learning master program in Geographic Information Systems and Science. After its 5th edition, a curricular renewal and revision process was started in order to: (i) adapt the curriculum structure and the study program to the Bologna process requirements; (ii) explore alternative curriculum paths; (iii) integrate efficient methods for curriculum evaluation and assessment; (iv) update curriculum contents, and, (v) develop new instructional materials and innovative ways to share and disseminate them. The outcomes of those processes are now being applied to the 6th edition of the course. Early feedbacks from student and teaching staff show promising results, and highlight the adequacy of the curriculum improvement approach applied to this project, and the necessity to extend it to include control methods for conduct evaluation, that systematically assess and allow the improvement, design, implementation and effectiveness of GIScience study programs.

The teaching of GIScience at the ISEGI-UNL – A groundbreaking experience

Founded in 1989, the Instituto Superior de Estatística e Gestão de Informação of the Universidade Nova de Lisboa (ISEGI-UNL), is one of the first Portuguese higher education institution offering a GI Science curriculum (Painho 1995; Painho 1999). In 1990, the teaching of GIS was introduced in ISEGI-UNL through an annual seminar for both the undergraduate and master degree programs. Later in 1993, it became an autonomous course of the master program in Statistics and Information Management and, in 1995, it generated a new course of the undergraduate study program with a similar designation (Grancho 2006).

In 2002, with over ten years of teaching experience in the area of Geographic Information Science, the ISEGI-UNL started to offer a master degree and post-graduate certificate in Geographic Information Systems and Science (GISscience). Developed in collaboration with

the UNIGIS International Association[1], this distance learning program was designed to give students a comprehensive education in both the theoretical and practical aspects of the analysis of geographic information, and it was conceived to meet the requirements of GIScience advanced education on behalf of the Portuguese speaking communities spread around the world, and of GIS professionals from a wide range of public and private organizations in Portugal, Brazil, Portuguese-Speaking African Countries and East-Timor. It was the first master program given by a Portuguese university institution fully available through the internet using technologies of distance learning (e-Learning). In its six editions, the postgraduate and master program has had more than 200 students (table 1), of which 22 have already presented and argued their master dissertations.

	1st Edition	2nd Edition	3rd Edition	4th Edition	5th Edition	6th Edition
Angola	1					1
Brazil	1		1			
Cape Verde	2	1	1		2	
UAE			1			
Spain				1		
Guinea-Bissau	2					
Mozambique	2			1	3	
Portugal	32	39	38	36	26	26
Switzerland					1	
Luxembourg						1
total	40	40	41	38	32	28

Table 1 – Students enrolled in the GIS postgraduate and master program offered by the ISEGI-UNL.

Motivations for the process of curricular innovation and adaptation in the GIScience master program

The innovative nature of the GIScience Master Program, both concerning the level of the teaching methods used, as well as the curricular structure proposed, determined, since its first edition, the necessity to implement an internal evaluation process, in order to monitor and assess the quality of the offered teaching and provide an answer to the less satisfying aspects of the course, specifically concerning the use of the technological platform that

[1] UNIGIS is a worldwide network of universities cooperating since 1990 in the design and delivery of distance learning in Geographical Information Systems and Science.

supported its operation (Painho, Peixoto et al. 2002; Painho, Peixoto et al. 2003). However, in 2004, new and important challenges gave rise to an encompassing and profound revision approach, in order to renew and update the GIScience study program of the ISEGI-UNL, of which we highlight:

- The need to adapt the studies program to the new requisites imposed by the implementation of the Bologna Process;
- The need to promote the offer of a wider variety of optional courses, in order to supply the student's different needs and expectations.
- The need to ensure a flexible curriculum, that allows the construction of alternative learning paths, suited for an effective exploration of the advantages frequently associated with distance learning education.
- The need to update and produce new contents and instructional materials, in the perspective of reusing and sharing courses among different higher education institutions.
- The need to explore the possibility of integrating a set of evaluation and assessment tools, so that the continuity of the curricular renewal and innovation processes can be maintained.

These challenges have led to the definition of an encompassing and in depth approach of adapting and changing the ISEGI-UNL master program in GIScience (Painho, Curvelo et al. 2006; Painho, Curvelo et al. 2007; Painho, Curvelo et al. 2007). By surpassing the purposes of a revision or curricular evaluation process, the procedures then initiated, led to the creation of a curriculum development model that permitted the framing of a set of curriculum activities (curriculum work), considered necessary for an effective improvement of the GIScience education, in particular:

- Ensured that the teachers and scientific community would have access to a collection of tools and functionalities, adequate for the systematizing, structuring and conceiving of GIScience courses.
- Made available a group of management, edition, and information gathering functionalities that would support the curricular development activities, and ensure the continuity of curriculum assessment and innovation.
- Allowed the students and the general public access to a vast amount of information that would contribute for a methodical and oriented exploration of GIScience related knowledge, and would better allow the comprehension of the *continuum* curriculum-teaching-learning.

- Integrated a set of tools that would be able to provide, with a high degree of systematization, a variety of information capable of supporting curriculum planning and management, both in the perspective of the education institutions and the students.

The *Curricula* Development Model in GIScience

Grounded on an encompassing approach of the curricular development process, in 2006, a first prototype of the GIScience *curricula* development model was conceived in order to allow the flexible integration and articulation of the components considered essential for the curriculum work activities (Hewitt 2006) -Fig.1.

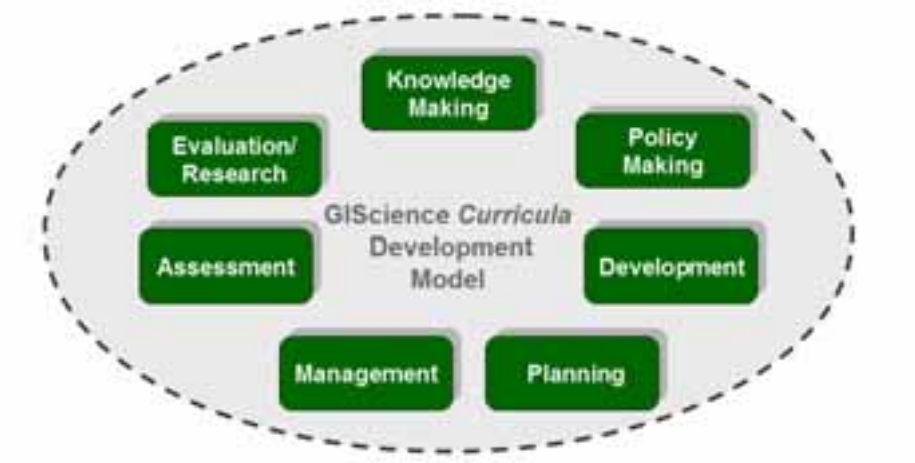

Fig. 1 - GIScience *Curricula* Development Model as a support for the Curriculum Work Activities (According to Hewitt, 2006, p.53).

This model, based on a curriculum conception as a *process* or *praxis (Tanner and Tanner 1995; Pacheco 2001)*, adopted as a fundamental point in the approach implemented, the design of an ontology enabling the establishment of knowledge structures likely to be contemplated in a variety of *curricula* proposals in GIScience advanced studies. These presumptions reinforce the need to frame the GIScience *Curricula* Development Model in the context of recent Terminology research, increasingly orientated towards facilitating information retrieval and knowledge engineering. In fact, the possibility of establishing multidimensional networks of concepts (Fig. 2), through the construction of a repository of terms related to the problem given in a particularly learning unit, increases a non compartmentalized and hierarchical idea of knowledge, by the establishment of semantic structures that tend to bring closer the association mechanisms of knowledge exploration, to the ways human memory and thinking processes occur. As a meta-representation of the contents of the Geographic Information Science, the model contributes for the acquisition of structural information, essential for the development of meta-cognitive competencies and for the realization of thematic researches, driven and oriented by knowledge.

On the other hand, the ontological approach intends to assist the curriculum work through a set of tools that can better integrate learning environments and open up access to a vast group of users, contributing to improve learning opportunities and promoting individual learning pathways, suitable for different needs and interests according to each student and its learning requirements. The integration of information visualization tools is one of the innovative aspects of the GIScience *Curricula* Development Model, promoting its representation understanding and exploration.

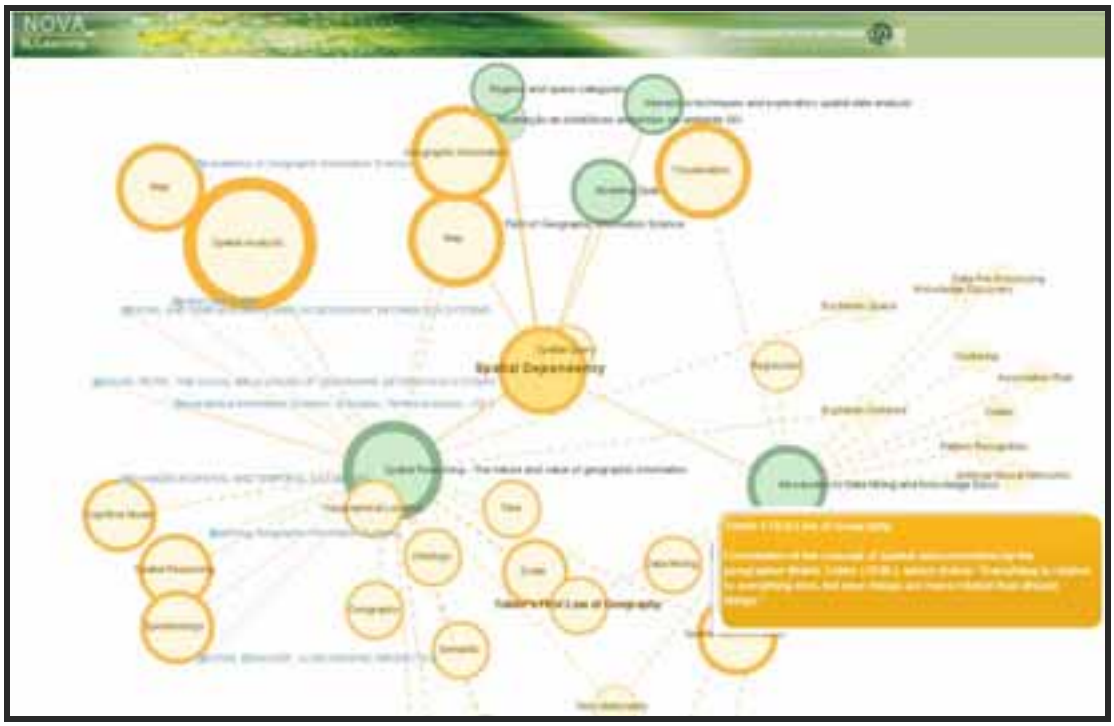

Fig. 2 – Example of use given to the GIScience *Curricula* Development Model visualization tool, showing the results from a query on "Spatial Dependency" information: a semantic network formed by concepts, learning units and bibliography associated with it.

The use of the GIScience *Curricula* Development Model in the 6th edition of the master program.

In 2006, the ISEGI-UNL undertook a comprehensive restructuring of the existing study programs in accordance with the principles of the Bologna Process, in order to guarantee academic recognition of studies abroad. This adaptation procedure led to a series of changes to the original programs, especially concerning the curricular structures and the study plans of the courses In this context the postgraduate and master program in Geographic Information System and Science was organized in a three semester course (Fig. 3) comprehending a total of 95 ECTS, distributed by five research area domains: Geographic Representation and Visualization; Geospatial Data Acquisition and Manipulation; Databases and Data Modelling; Geospatial Data Analysis and Geocomputation; Geographical Information Systems, Society and Organizations.

1st Semester	2nd Semester	3rd Semester
Geographical Information Systems and Science 7,5 ECTS	GIS Applications II 7,5 ECTS	Dissertation 35 ECTS
Cartographical Sciences 7,5 ECTS	GIS in Organisations 7,5 ECTS	
GIS Applications I 7,5 ECTS	Remote Sensing 7,5 ECTS	Internship 35 ECTS
Databases 7,5 ECTS	Geospatial Data Mining 7,5 ECTS	
Geospatial data models 7,5 ECTS	GIS and Modelling 7,5 ECTS	Project 35 ECTS
	(*) Project Management – 3,5 ECTS a) + GI Standards - 4 ECTS b)	

Compulsory Course
Optional Course

(*) Optional Courses (eduGI)
a) University of Münster, Institute for Geoinformatic, Münster, Germany
b) University Munich, Munich, Germany

Fig. 3 – The study plan of the GIScience master program after fulfilling the Bologna requirements.

For the purpose of evaluating the level of adequacy and response capability of the GIScience *curricula* development model to the challenges that motivated its construction, its use was partially tested on the process of (re)designing the GIScience master program curriculum in order to fulfil the requirements of Bologna reforms. In the first stage, the *curricula* development model was used in the attempt to identify the program contents considered essential in the acquisition of the generic skills defined for the second-cycle degree (JQI 2004). Thus, and by exploring the set of learning units that integrate the curricular development model, it was possible to recognize the 5 learning units that came to integrate the only compulsory course of the new study plan of the master program: Geographic Information Systems and Science (Fig. 4).

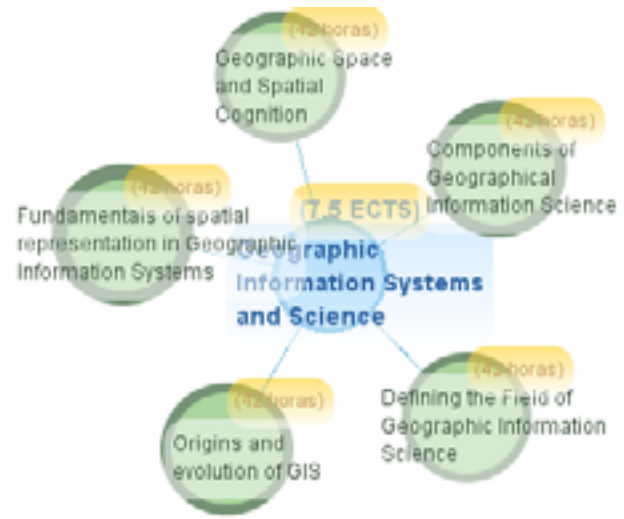

Fig. 4 – The 5 core learning units that comprise the Geographic Information Systems and Science compulsory course

Taking as a reference the technical norms for the requests on the creation and harmonization of programs for the second-cycle degree, the information requirements contemplated in the database design were the ones that try to answer the issues of organization needs in creating and harmonizing the courses descriptions (as well as emitting and *Diploma Supplement),* of which these should be highlighted:

- Identification of the learning outcomes and translation of those competences in terms of curriculum contents;
- ECTS credit attribution based on estimated students working load in hours;
- Identification and adaptation of the teaching methods applicable;
- Description and adaptation of the evaluation methods applicable.

During the process of constructing the contents for the new *Geographical Information Systems and Science* course (e-book, self evaluation exercises, and on-line presentations), the *curricula* development model was frequently put to the test, in order to ensure that it could cope with the crossing of information, diverse in nature, which would later be demanded of it.

In fact, during this process, it became evident the adequacy of the *curricula* development model for the management and manipulation of vast amounts of information (consulted bibliography, identified concepts and topics, confronted with other *curricula* proposals and, lastly, projects identification, institutions and important features related with the use of geographic information and associated technologies) necessary for the production of rich and diverse contents.

Lastly, the use and exploration of the visualization tool was promoted among the students, having in mind the investigation of terms and concepts essential in the area of GIScience.

Conclusion

The recent advances in geographic information domains, the growing need for professionals in these areas and the use of new technologies of information and communication in education, are all factors which concur for a broad dissemination of the GIScience *Curricula* Development Model within the framework of lifelong learning. The GIScience *Curricula* Development Model integrates a set of components that, by its nature, format and content may interest the teaching institutions and scientific communities as well as the general public. The development both in Portuguese and English, of a web-based tool, may contribute for a wide dissemination and promotion of the results obtained in the various stages of the project. Additionally, it is expected that the ontological approach will contribute to create a GIS-learning community, by giving way to shared information, contents and

knowledge, sought by individuals and organizations with common interests. With this model we expect to facilitate access to GIScience learning opportunities to diverse groups under different conditions and locations. The possibility of open access to GIS education on the Portuguese speaking countries will be explored through specific and regionally oriented scientific actions.

However, the expected repercussions of this project are not limited to the GIScience domains. The possibility to expand this approach to different knowledge areas and application domains, may contribute to the adequacy of teaching methods and curricular investigation progress (curricular theory and practice) and, mainly, it may add in the creation of the necessary conditions for the promotion of an effective Lifelong Learning, the "guiding principle for provision and participation across the full *continuum* of learning contexts" (Commission of the European Communities 2002).

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