

GI-education: the impact of EduMapping

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ABSTRACT

The creation of a European Higher Education Area during the last 20 years has resulted in a considerable degree of harmonization when it comes to the structure of higher education in the European countries. With regard to geoinformation (GI) education, less progress has been made. Formats for course and curriculum descriptions vary per organization and languages vary per country. For the described content a central reference on domain level seems absent. The reference documents published in the United States (2006: the Geographic Information Science and Technology Body of Knowledge, 2010: Geospatial Technology Competency Model) have not yet been widely accepted in Europe, but seem useful. The EduMapping method aims at concisely characterizing GI course or curriculum content in a label, to be added to existing descriptions. This paper points at a role for EduMapping as a connection between the European multinational and multilingual situation and the American reference potential. Application of EduMapping might help Europe to achieve the objectives of the Europe 2020 Strategy.

KEYWORDS

Body of Knowledge, GTCM, Europe 2020, EduMapping, EHEA, ECTS, label

DRIVERS FOR CHANGE

This paper considers two drivers for change of academic GI education in Europe and explores their possible impact. The first driver consists of four strategic steps taken by the European Union during the last 20 years. The steps are: the introduction of a common educational credit system (ECTS¹) in 1989 (European Union 2009), the start of the Bologna-process in 1999 (Council of Europe 2010) and the launch of the European Qualification Framework in 2008 (European Union 2008). Among other measures, they were instrumental to implement the European Higher Education Area (EHEA). A fourth step is the Europe 2020 Strategy (European Commission 2010), that aims to improve the European economy by means of seven flagship initiatives.

The second driver consists of four American contributions in the same period to align / unify / harmonize GI education. They are: the NCGIA² GIS Core Curriculum (Goodchild and Kemp, 1990), the GI Science and Technology Body of Knowledge (DiBiase et al., 2006), referred to hereafter as “GI-BoK”, the GIS Certification Institute (GISCI, 2008) and the Geospatial Technology Competency Model (GTCM) (DOLETA, 2010).

This quartet represents the development from academic domain specialists describing GI education as “best practice” all the way to GI as a recognized economic sector with its own workforce. In this workforce the employees need education to develop their geospatial competencies. If they acquired those competencies outside accredited education or training, and need their GIS-capabilities

¹ ECTS: European Credit Transfer System, a unit for study load. On average across the EHEA countries, one ECTS represents about 28 hours of student work.

² NCGIA: National Center for Geographic Information and Analysis. <http://www.ncgia.ucsb.edu/>

recognized, they can follow the certification procedure of GISCI and become a GISP, a geographic information systems professional.

Top down and bottom up

The European driver results from a top down approach by the European Union: to make education in Europe contiguous and coherent, a structure was implemented to replace the multinational diversity. This structure harmonizes the educational structures of countries and makes diplomas and degrees from the countries in EHEA mutually recognizable. For that purpose, the European Qualification Framework (EQF) (European Union 2008), will provide a translation between educational levels in the countries. To that end EQF has defined eight different educational levels to refer to. It is up to the various knowledge domains in the countries to indicate at which of the eight EQF levels educational programmes in their domains connect with this structure.

A GI-related European structure that does exist is the INSPIRE Directive, entered in force in 2007. Its objective is a European spatial data infrastructure to enable internationally harmonized environmental data availability (European Commission 2007) across all member states. However, INSPIRE is environmental policy oriented and has no educational intentions.

The American driver represents a bottom up approach by consortia (NCGIA, UCGIS³) with the intention to improve education in the geospatial domain and make it more relevant to employers. Their approach evolved from describing the GIS Core Curriculum via describing the GI knowledge domain (GI-BoK) to identifying “the foundational, industry-wide, and industry sector-specific expertise that distinguishes, and binds together, successful geospatial professionals” (DiBiase et al., 2010) in GTCM.

GTCM is a product of the American government’s Department of Labor. It is the result of the designation in 2003 of Geospatial Technology as a potential job-producing industry (DOLETA, 2003). Although it refers to GI-BoK when dealing with GI-specific competencies, it covers seven other groups of competencies. One of the contributors characterizes the difference as follows: [GI-BoK] “is an exhaustive listing of formal educational objectives related to geospatial information science. The GTCM is more generalized and tries to focus on those competencies and tasks that a geospatial professional may encounter over the span of a career“ (Francica, 2010). This sequence shows that - in the US - the bottom up approach has reached the top.

EHEA progress

The situation is that in the majority of the 48 EHEA countries the majority of the educational programmes are structured according to the Bachelor–Master model (Rauhvargers et al., 2009). Also ECTS is used in most of those programmes (Rauhvargers, 2010) – in a way.

With regard to ECTS, the EU-ideal is: “The use of ECTS, in conjunction with outcomes-based qualifications frameworks, makes programmes and qualifications more transparent and facilitates the recognition of qualifications. ECTS can be applied to all types of programmes, whatever their mode of delivery (school-based, work-based), the learners’ status (full-time, part-time) and to all kinds of learning (formal, non-formal and informal).” (European Union 2009), p7.

³ UCGIS: University Consortium for Geographic Information Science. This group of about 70 American universities created the GI S&T Body of Knowledge. <http://www.ucgis.org/>

An aspect that the EHEA countries still have to work on is the basis for ECTS-allocation. The application of ECTS should be based on both ‘student workload’ and ‘learning outcomes’ and in 2010 many education systems were struggling with those concepts (German Academic Exchange Service (DAAD) et al., 2011), p.17. In 2009, five different dominant practices were found in 37 higher education systems. In 2009, just 16 of the EHEA countries used Learning Outcomes (LO) as a basis for credit allocation, four of which did not use Estimated Average Student Workload. This EASW was used in 30 countries of which 18 did not use LO. Eleven countries based the ECTS amount on teaching/contact hours (German Academic Exchange Service (DAAD) et al., 2011), p.40.

The Europe 2020 Strategy (European Commission 2010) expects EU Member States, among many other things, to “reinforce cooperation between universities and business” and “enhance cross border co-operation” (p.11). They also need “to enhance the openness and relevance of education systems by building national qualification frameworks and better gearing learning outcomes towards labour market needs” (p.11).

GI domain in EHEA

No signs have been observed indicating that, at EU level, the GI knowledge domain has been or will be addressed like in the United States. If the European part of the GI domain wishes to support the 2020 strategy, it should take initiatives.

Of course the GI-domain is not sharply defined, as was sketched in the GI-BoK report (DiBiase et al., 2006). Nor is it a single entity: geographers, cartographers, remote sensing specialists and land surveyors have their own professional organizations. The software manufacturers have their followers and conferences. In Europe there is the additional problem of diversity in languages and national organizations. Judging from their websites, Euro-wide GI-oriented organizations like Eurogeographics, EuroSDR or EuroGI seem to have no ambitions regarding GI education. At the other hand there is UNIGIS (<http://www.unigis.net/>), a Europe-based global network of higher education institutions which offers GI distance learning on MSc and Professional Diploma levels. However, with GI distance learning offers in general the question is which country’s quality standard they comply with and how the courses relate to the GI knowledge domain.

GI education gap in Europe

The American driver has only a limited influence in Europe. The undocumented impression of this author is, that the NCGIA Core Curriculum in the years after 1990 seems to be present in the collective memory of many older GIS teaching staff. For GI-BoK it is another situation. According to Masik (Masik, 2010), of her 113 survey respondents from 99 different universities in 27 countries (25 in Europe), 40% is aware of GI-Bok, 22% has been using it and 25% intends to use it. GTCM, of a more recent date, seems very much less familiar in Europe, but this is also an undocumented impression of this author.

The conclusion is that the American driver does not (yet?) work in Europe because of the more diverse situation. The European driver does not (yet?) reach the GI domain. The question is: what could be done to bridge this gap?

A bottom up approach in Europe should be more basic than in the US and provide a foundation for more organization, more coherence in the GI domain. It should respect the European driver (i.e. not interfere with, but add to structures under construction) and make use of the American driver where possible.

The AGILE⁴ EduMapping Initiative operates along these lines. Started in 2009, its objective is to create an overview of existing GI education offers in Europe, using GI-BoK to characterize their nature and at the same time making courses and curricula comparable on their content.

The idea to create an overview is not entirely new. Presently, Rostock University in Germany hosts a website (http://www.geoinformatik.uni-rostock.de/ausbildung_map_en.asp) with a map showing locations of 92 GI education offers in mainly the German speaking countries, with links to descriptive websites. At the EUGISES 2010 conference a similar subject was brought to attention (Kotzinos et al., 2010).

METHODOLOGY

This project started in 2008 in exploration mode. Gradually, tactical and strategic aspects developed, as is shown in the following concise overview.

The overall strategic objective was and is to contribute to the quality of education in the GI domain by using the GI-BoK domain description. For that purpose, various organisational and technical tactical decisions were made so far. They were intended to generate interest from colleagues and from professional organizations by contributing assessments, help analyse the results or even help to get funds for the work. Of course, to get their interest, the results of the EduMapping work itself had to be shared and reported about.

Organisational:

- workshops arranged at the AGILE conferences of 2009, 2010 and 2011
- got the AGILE Board to accept work on EduMapping as an AGILE Initiative (2009)
- created papers (AGILE 2011) and posters, made presentations at conferences (AGILE 2008, INSPIRE 2010, ISPRS 2010, EUGISES 2010 and at the AGILE workshops)
- meetings with representatives of ISPRS, ICA, AGILE and of BoK2 (2010, 2011)

Technical:

- designed the mapping approach using GI-BoK as a registration form in Excel
- designed the EduMapping label as a concise characterization of a teaching offer
- experimented with visualization of multiple EduMapping assessments in an XY system
- obtained assessments for individual courses and complete curricula on vocational, professional and academic levels
- experimented with obtaining assessments from different persons for the same course
- experimented with applying EduMapping to job descriptions

The subjects to discuss and report about in workshops and papers are the EduMapping assessments. First, the collection method is of relevance. The designed Excel sheet, supported by an overview of the GI-BoK Knowledge Areas and their Units, as well as user instructions for the Excel sheet, was presented to GI teaching staff among the author's acquaintances and to people met at meetings and conferences. Together these materials are referred to as the "EduMapping kit". The approached persons were asked to make an assessment of a course or curriculum they were involved in. The overview of GI-BoK was added to help the respondent in case of insufficient familiarity with GI-BoK.

⁴ AGILE: Association Geographic Information Laboratories Europe, <http://www.agile-online.org/>

Also, each respondent was asked to describe in 9-99 words what they dislike and like in the EduMapping procedure. The limitation was intended as a stimulus to receive comments.

Second there is the mapping method, meant here as connecting elements in a course description with elements in the GI-domain description, i.e. GI-BoK. This mapping activity has two key steps and three challenges. The first is that the person making the assessment, the assessor, has to know what the terms used in the description refer to. Then the task is to select the best matching GI-BoK Knowledge Area, or even better: selection of the more specific Units within a Knowledge Area. The challenge in that is finding prospective matches in the paper document that GI-BoK is. That includes yet another challenge: translating the GI-BoK terminology to what the assessor thinks is meant in the course description. A consequence of this need for understanding the meaning of terms in both the description and GI-BoK is, that the teacher of a course is the best candidate to make its EduMapping. So, the EduMapping form asks for how the assessor is involved with the described course. Answering options, in order of descending course content expertise are: teacher, involved, ex-participant, skilled outsider, other. This is supposed to help judge the weight of an assessment. The necessity for making the distinction became clear after comparing the EduMappings for the same course, made by persons with different degrees of involvement.

RESULTS

One category of results is what is produced during the work. They will be described here first. Then there is the organizational context. A third category is that of expected future results.

Products

Actions to generate more interest for the use of GI-BoK to underpin the GI domain and develop EduMapping resulted, apart from the above mentioned EduMapping kit, in a number of papers, reports, posters and presentations at various occasions. They reflect the development of the EduMapping concept since 2008. The important ones are the two papers in which the concept is described (Rip and Van Lammeren, 2010) and a first analysis of the collected data until the end of 2010 (Rip et al., 2011). Access to those papers and a number of other publications is provided via website <http://www.geo-informatie.nl/rip001/edumapping>. From this webpage also the EduMapping kit can be downloaded.

A number of EduMappings has been collected so far: 24 of programmes (Figure 1) and 23 of sets of one or more GI courses outside programmes from eight European countries. As each programme consists of a number of courses, the total number of collected courses is 265. The educational levels included are: “vocational”, “professional” and “academic”. Their size varies between 0.6 ECTS (a two day course offered by ESRI-NL) to 240 ECTS. Content areas include: Geoinformation, Spatial Analysis, Cartography, Geomatics, Earth Observation, Geography, Remote Sensing, Geodesy, Surveying, Spatial Data Infrastructure, Data Mining, Algorithms and Databases. At the moment they are stored locally in Excel sheets, but the intention is to place them in an online repository.

Assessment summary	ECTS size	share
GI subjects in BoK	45.6	38%
<i>AM. Analytical Methods</i>	13.0	11%
<i>CF. Conceptual Foundations</i>	0.0	0%
<i>CV. Cartography and Visualization</i>	0.0	0%
<i>DA. Design Aspects</i>	1.0	1%
<i>DM. Data Modeling</i>	2.0	2%
<i>DN. Data Manipulation</i>	0.0	0%
<i>GC. Geocomputation</i>	5.0	4%
<i>GD. Geospatial Data</i>	23.6	20%
<i>GS. GI S&T and Society</i>	0.5	0%
<i>OI. Organizational & Institutional Aspects</i>	0.5	0%
GI subjects, Not in BoK 2006	6.0	5%
Application of GI subjects in generic components	39.0	33%
Non-GI subjects	29.4	25%
sum	120.0	100%

Figure 1: Example of an EduMapping label, characterizing the Master of Earth Observation curriculum of K.U. Leuven, assessed in February 2010 by prof. J. van Orshoven, coordinator.

The request for comments, sent out with every EduMapping request, produced a number of remarks and opinions. Out of the 13 assessments received between August 2010 and August 2011, (representing nine individual courses plus four programmes containing 57 courses) seven respondents gave constructive criticisms or made positive remarks. Some errors in the Excel sheet were reported and suggestions were made to improve the instructions. Some assessors of Remote Sensing courses complained about the structure (fragmented subjects) and content (new subjects of last five years missing) of GI-BoK. Others remarked on the ease of use, or about the beauty of the method. In one case two respondents, together teaching one particular course, expressed their satisfaction with the degree of similarity of their independent assessments.

For a number of courses and curricula more than one assessment has been collected. This could be used to compare interpretations of assessors, taking into account their type of involvement. It could also be useful for discussions between teaching staff how to best characterize the courses by means of EduMapping.

Another point of interest is the diversity in course names, which might be confusing for people considering to follow an offered curriculum. In (Rip et al., 2011) is shown how a variety of GI courses could be clustered to a common theme within the GI domain, based on their characterization in terms of GI-BoK (Fig.2).

An interesting side line is the concept of JobMapping. This involves trying to characterize job offers using GI BoK. Some early experiments done by De Bakker (De Bakker, 2011) suggest that this could contribute to a better connection between GI education and GI employers when it comes to job matching.

Class 2: Cartography and Visualization

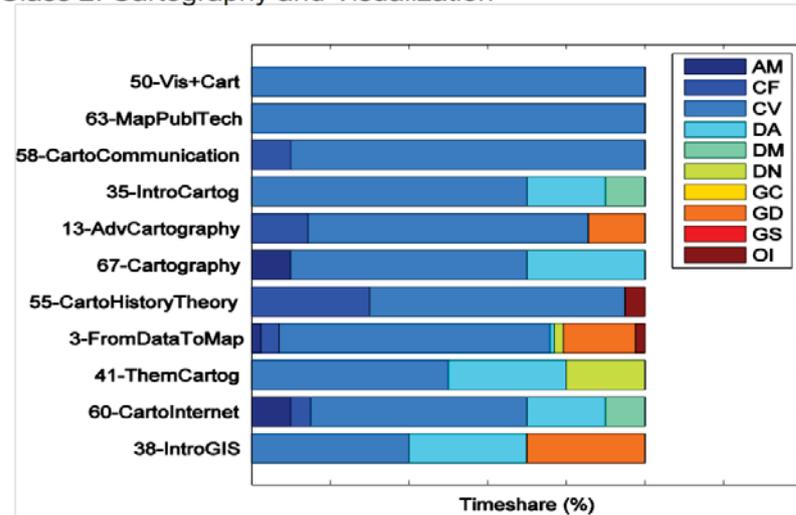


Figure 2: Clustering of course assessments in the GI-BoK Knowledge Area "Cartography and Visualization". The course names are on the left. Source: AGILE 2011 presentation by D.Kotzinos of Rip et al. 2011

Organizational context

The project started as a one man action in 2008. Gradually, as a result of the AGILE Preconference workshops, a circle of interested colleagues in various European countries came to exist. This helped to get an idea of proposed improvements on GI-BoK, like an ontology based GI curriculum building application (Painho et al., 2007). Other comments on GI-BoK have been formulated by (Reinhardt and Toppen, 2008) and (Toppen and Reinhardt, 2009). Also it helped to submit the EduMapping work as an AGILE Initiative. A further stimulant was the set of meetings in 2010 and 2011 in Zürich, Utrecht and Paris with the BoK2 project leader and representatives of the boards of AGILE, ISPRS and ICA.

Future

Because EduMapping is new, predicting future impact has a high degree of wishful thinking. In order to give that some credibility, a number of assumptions is listed below. Obviously, before there will be impact, these assumptions will have to become reality. After the assumptions follows a number of aspects of the impact.

The assumptions are:

- GI-BoK, or its next version, becomes more widely accepted among GI education organizations as a reference description of the GI domain;
- GI-BoK transforms from a hierarchical structure on paper into an online facility, more richly structured, better searchable and more interactive and up to date. Sean Ahearn, leader of the American BoK2 team sketched their objective for about 2015 (Ahearn et al., 2011) along those lines during the Paris 2011 meeting with delegates of AGILE, ISPRS and ICA;
- Professional organizations in the GI domain intensify cooperation regarding education;
- The educational accreditation organizations in the European countries welcome a reference description for the GI domain;
- GI employers recognize the value of a domain reference for improving job descriptions;
- The idea to compactly characterize GI teaching offers by means of the EduMapping label is considered useful by educational organizations and by GI students;

- Funding will be in place to stimulate awareness of the GI domain description among GI educational organizations, GI employers and to enable cooperation with the BoK2-team in the United States.

If these points become a reality, then a future scenario for the GI domain is:

- Accreditation organizations will require submitted applications for GI educational offers to contain EduMapping labels to characterize the programme;
- The professional organizations in the GI domain
 - accept GI-BoK and contribute to it from their specialist part of the GI domain;
 - accept EduMapping and ask their members to start using EduMapping labels for characterizing all courses and curricula;
- Educational organizations
 - learn the language of GI domain description and how to apply EduMapping;
 - use the EduMapping label as a component of course descriptions in study guides, and update it yearly;
 - compare their own GI educational offer with programmes elsewhere by means of the EduMapping label, and further develop their GI teaching niche;
 - better profile themselves for prospective students from other cities or countries
- Employers
 - learn the language of GI domain description and how to interpret EduMapping labels;
 - include a reference to GI-BoK in their job descriptions and advertisements, maybe by means of JobMapping.
- It becomes possible to set up an online repository of EduMappings, accompanied by analytical tools to search and compare GI educational offers, or analyse developments.

CONCLUSION

The description of the results of the AGILE EduMapping Initiative is intended to convince the reader that EduMapping is a valuable concept. Producing a label is a simple procedure. Its outcome will help to overcome the diversity in descriptions of GI education in multinational, multilingual Europe, whereas it also has potential as one of the linking pins between the professional organizations in the GI domain.

A challenge for wide acceptance of GI-BoK as a domain description is the fact that GI-BoK is about to be renovated. Another challenge is that, before GI teaching staff and GI programme directors can use it for EduMapping, users must familiarize themselves with the GI-BoK structure and terminology, just like a new language. As soon as the population of the GI domain has mastered that language, a built-in risk of translation will become less serious: subjectivity of assessors and readers.

Work is necessary to help the assumptions mentioned in the previous chapter become reality. The key stakeholders all should play their part. However, as it has not yet been possible to check the reception of the EduMapping concept with the accreditation organizations, or with the GI employers, there is a risk that such work is not successful.

Fortunately, a number of conditions is favourable for starting the implementation of EduMapping in Europe. Presently, in the USA work is being done to prepare the foundation for BoK2, the successor of GI-BoK, funded by the American National Science Foundation. The actual construction - not included in the present project - is planned to start in the course of 2013, if funding will be obtained. In

Europe, the implementation of cross border recognition of GI diploma's and degrees could benefit from that, if GI-BoK would be recognized as the first version of the GI domain reference. Besides, the Europe 2020 Strategy calls for better links between education and business. To achieve that in the GI domain, GI-BoK, BoK2 and GTCM would be helpful, with EduMapping as the link to GI-BoK.

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