

## GI S&T Body of Knowledge: basis for e-learning, certification and curriculum planning?

Frans I. Rip

Laboratory for Geo-information and Remote Sensing,  
Wageningen University and Research Centre, The Netherlands  
< [frans.rip@wur.nl](mailto:frans.rip@wur.nl) >

**Abstract.** In 2006 a first version of the GI S&T Body of Knowledge (GI BoK) was published by the American Association of Geographers. The GI BoK's objective to support education makes it relevant to look at aspects of e-learning. Based on that, a number of possible strategic targets to enable further development and broad acceptance of GI BoK are proposed. Within Europe, the agent that might make this happen could be AGILE.

**Keywords:** Body of Knowledge, Geo Information Science and Technology, e-learning, standards

### INTRODUCTION

The objective of the GI S&T Body of Knowledge (hereafter referred to as "GI BoK") is to help "bridge the gap between the GI S&T higher education community and the practitioners, employers, and clients who populate the various GI S&T professions" (DiBiase *et al.* 2006). The BoK editors consider the GI domain as a 'moving target', and this first version of the BoK as a start. They hope to receive international feedback.

### GI BOK

This first edition of GI BoK describes the GI knowledge domain as a hierarchical outline, composed of three tiers, called "knowledge areas" (10), "units" (73) and "topics" (many).

Knowledge Areas are constituted by a number of Units, and each Unit consists of a set of Topics. Topics embody representative concepts, methodologies, techniques and applications. Topics are defined in terms of one or more formal educational objectives.

Educational objectives broadly describe desired educational outcomes, which may require weeks or months to learn. The formulation of the objective in nouns and verbs refers to the required level of knowledge and the cognitive processes involved in fulfilling the objective. The 3 knowledge levels and 6 cognitive processes, juxtaposed in a matrix, provide categories to classify the objective.

An example of a single educational objective: 'compare and contrast attribute query and spatial query'. This is one of a set of 5 objectives, together embodying the topic 'Spatial queries' in the unit 'Query operations and query languages'.

### HOW TO CONTINUE?

The initiative of the AGILE<sup>1</sup> Education Working Group to formulate a European perspective on GI BoK (2007) triggered an attempt to formulate a future perspective, that might inspire AGILE's Council.

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<sup>1</sup> Association of Geographic Information Laboratories for Europe

That perspective is presented here. It was created by relating GI BoK to aspects of e-learning. The relationships were embodied by declaring those developments, in an extrapolated and idealized form, applicable to GI education. From the resulting set of relationships some possible strategic targets for AGILE will be proposed.

## **SILHOUETTE OF FUTURE GI TEACHING**

The development of the internet has stimulated the development of standards and tools to enable distance learning, or e-learning. It seems only logical to use these standards and tools to all education, as far as applicable.

Based on that idea, a silhouette of future GI teaching was created by extrapolation combined with wishful thinking. A number of aspects stand out. A concise description follows.

The order of the aspects follows the logical order of educational practice:

- Write specifications for Learning Objects (lesson, course, curriculum)
- Design and create the specified Learning Objects
- Teach (Deliver the created Learning Objects)
- Test

### **1 Write specifications for Learning Objects**

This process requires identification of the sections of the knowledge domain to be taught, and the intended increase in abilities, expressed in change of competence level. If the Learning Object is multi-part, then the sequence of the parts must be determined. For each part, suitable learning styles must be chosen.

Ideal:

- a) Educational institutes offering a GI curriculum have based the contents of their curriculum on GI BoK, a widely shared view of the GI knowledge domain among GI teachers at other educational institutes and with GI professionals in the field. This is a stimulus for (international) co-operation between institutes.
- b) Most institutes will teach only part of the GI BoK because of their specialization. Because all institutes use GI BoK as a reference, the differences and similarities in their curricula can be identified on a common basis. This transparency is a stimulus for (international) exchange of students.
- c) The description of the GI domain is laid down in a GI BoK document. Its contents are managed by an international committee, consisting of people representing all parts of the GI S&T domain. That includes surveyors, remote sensing specialists and cartographers.
- d) The items in the BoK have attributes that refer to a level of competence it belongs to. This attributed is used for sequencing Learning Objects.
- e) GI BoK items have attributes to indicate suitable learning modes (practicals, reading etc.).

### **2 Design and create the specified Learning Objects**

This involves the construction of a learning object according to the specifications, using pedagogical guidelines, using learning materials from a repository, and most likely creating new learning materials as well.

Ideal:

- a) At educational institutes, tools are available to design Learning Objects. This enables the teacher to design lessons under the guidance of pedagogical guidelines like ECLASS (Gerson 2000) with a tool like ELML (Fisler *et al.* 2005), using the learning materials in the local repository of the LMS.

One step further would be the availability of a curriculum design system, something like CCDT (MassOne Newsletter, 2006). Other examples are the ADISA software tool (Paquette 2007) or the GISc-Curricula Development Model, with visualization tool (Painho *et al.* 2007).

- b) Items in the GI BoK have attributes that characterizes them in terms of Cognitive Process and Knowledge Type. Those attributes are useful when putting learning materials together when designing a lesson, course or curriculum.
- c) The learning objects (lessons, demonstrations) are the result of design work. They comply with form and content requirements. These requirements are formulated in technical standards like SCORM (ADL 2007) or IMS Content Packaging (Wilson *et al.* 2002), and in content standards like IEEE's Learning Object Metadata (WG12: Learning Object Metadata 2002).
- d) The contents of each learning object are a selection from GI Bok, described in the content metadata section of the learning object.
- e) Levels of competence are used to indicate required ability levels at entry and exit of Learning Objects. This helps to sequence single lessons and courses.
- f) The referencing methodology has been internationally accepted among GI professionals and is in use at all organizations that educate, train or certify about GI. It is implemented in software systems for educational design, like in the MISA method (Paquette 2007).

### **3 Teach (Deliver the created Learning Objects)**

Learning from what is taught is the essence of the education process.

Ideal:

- a) At educational institutes, a Learning Management System (LMS) is in place, that supports teachers in delivering lessons, and organizing their (digital) learning materials (images, texts) in a repository. Examples: MOODLE, or Blackboard.

As an alternative to lessons in class, students can follow lessons and take tests via the internet, at their own time and place. An example of the latter is ESRI's 'Virtual Campus' website (ESRI).

- b) Between institutes, learning objects will be exchangeable from one LMS to the other. The only thing teaching staff has to check is if the course content is relevant for the part of the GI BoK that is taught at their institute. And they would have to check if the growth in capabilities, intended with the course, fits in their teaching objectives. The course content and its intended entry and exit capabilities are stored in the course metadata.
- c) Personalizing the learning experience contributes to learner satisfaction by means of Adaptive Educational Hypermedia (AEH) systems (Karampiperis *et al.* 2005). For this, ontology based models of the "Knowledge Space" and of the "User Model" interact to find the best next learning step for a student.

### **4 Test**

Testing if the specified intended increase of abilities has been acquired is the final step in the process. It is essential for awarding diploma's or certificates.

Ideal:

- a) A diploma describes what a student has learnt in terms of competencies with regard to items in the GI BoK.
- b) GI employers are familiar with the way the competencies of that person are described in the diploma. They also use these competencies to formulate the GI-specific part of job descriptions.
- c) GI-professionals, who did not formally graduate in GI, can have their GI abilities certified. This makes them comparable to the GI-graduates. For that purpose, certification institutes like GIS Certification Institute apply the same set of GI competencies as the educational institutes. So they are BoK-based too.

In this silhouette, GI BoK is very important in the specification phase and in the design phase, because it helps provide structure and coherence. For teaching and testing phases, BoK presence is a background property, which nevertheless contributes to quality assurance of the education process.

## NECESSARY CHANGES

The above description, however limited in scope, and being subjective and time bound, helps to identify points of interest for a next version of GI BoK.

In order to get closer to the described silhouette of the state of things, improvements are necessary for the following aspects related to GI BoK.

\* The GI BoK should be accepted across national boundaries and among GI-related professional bodies as a standard for describing content for jobs and education in the GI domain.

\* Competencies (a package of attitude, skills and knowledge), describing a person's GI abilities, should be used in the GI BoK to indicate the relative position of BoK items. The referencing methodology is based on the must-have principle: to fulfill this role in that context, a person should know about these subjects, have those skills and assume such attitude. A step in that direction has been proposed earlier (Rip 2006).

\* The GI BoK should be structured as ontology in order to be able to function as a backbone in an e-learning context, and provide interfaces to aforementioned design and delivery tools like MISA, GISc-CDM, AEH or others.

One might wonder where exactly the present version of GI Bok can be situated in the array of knowledge infrastructure tools (from folksonomy to ontology) as presented on page 254 of (Lambe 2007). However it is clear that the present hardcopy version of GI BoK do not facilitate any relationship based interaction with the developing set of tools for e-learning.

\* Standards for description of learning materials and learning objects should have a facility to accept domain specific content descriptions: a GI BoK plug-in should be facilitated by the standards, and developed by the players in the GI-field.

Apart from that, the standards must also be updated to enable reuse of learning objects. The present standards, for instance LOM and IMS LD (IMS 2003), are too limited for that purpose (Jovanović *et al.* 2007).

## CONCLUSION

The AGILE BoK initiative is about a European perspective on GI BoK. GI as a knowledge domain is not related to the boundaries of a continent, but organization of (higher) education in Europe is. Presently, a European Higher Education Area is under construction. In that structure, the

linking pins between organization of (higher) education and the knowledge domain will be the accreditation institutions, which take care of the quality assurance of education in a country (Erichsen 2005). In their processing, the use by the applicant of a domain specific international standard is checked. For the GI domain, a future version of the GI BoK might be that standard. AGILE would have to look for ways to be instrumental in this process.

It seems a major challenge for organizations in the GI field, as well as for organizations in the field of educational technology, to bring about developments as indicated. If the professionals and the educators in the GI S&T field appreciate the importance of a fundamental role for GI BoK, a strategy must be set out to make it happen. For Europe, AGILE might be the agent.

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