

# Curriculum Design Based on the UC GI S&T Body of Knowledge Supported by a Software Tool

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## INTRODUCTION AND MOTIVATION

The usage of the UCGIS Geographic Information Science & Technology (GI S&T) Body of Knowledge (BoK) [DiBiase et al, 2006] for various purposes has been discussed intensively at quite a number of workshops and conferences in the European GI communities since its introduction in 2006 [e.g. Johnson et al, 2006, Reinhardt and Toppen, 2008, Rip, 2008]. In general, these discussions reveal the BoK as a valuable tool which could be used for e.g. curriculum design and comparison. But some weak points have also been identified beyond its expediency, e.g. inadequate representation of SDI topics within the content of the BoK, missing consideration of a “depth-factor” related to the BoK etc. Moreover, some people expressed the opinion that a BoK as a pure text is not very comfortable to use and therefore, conveyed a clear demand for a machine readable implementation of the BoK so that the BoK content could be stored in a data base and further extended by developing suitable tools to handle the data and to support various user activities.

This paper deals with the usage of the BoK for curricula design, which includes a short discussion of extensions of the BoK as well as some tasks in curriculum design. The main part of the paper is to introduce a software tool which allows for the usage of the BoK and other sources for some tasks in curriculum design. The paper is therefore structured in the way that the next section includes a short discussion of possible extensions of the BoK and some comments on the way these extensions are developed. Thereafter, some selected tasks in curriculum design are described. These tasks should be supported by the software tool which is described in the following main section of the paper. Finally some conclusions are drawn.

## SOME COMMENTS ON THE EXTENSION OF THE CONTENT OF the BoK

As already stated in [Reinhardt and Toppen, 2008] the BoK primarily includes a Geographic View on GI S&T and especially IT issues are not adequately represented. In [Reinhardt, 2011] a suggestion was made to add a SDI and a programming knowledge area (KA) to the BoK. For the SDI KA the following topics have been suggested:

### **Spatial data infrastructures (SI)**

- SI1 General purpose and background, initiatives, non-technical aspects, laws etc.
- SI2 Metadata (purpose, models, challenges)
- SI3 Introduction to Interoperability (syntactic, semantic)
- SI4 Basics of Services (HTTP, REST, SOAP)
- SI5 Services I (basics, WMS, WFS)
- SI6 Services II (advanced, WCS, WTS ...)
- SI7 Security of Services (authentication, access control ..)
- SI8 Relevant Standards (GML, Spatial Schema ...)

It was also emphasized that the content of these knowledge areas is seen as a first draft and should be defined by the community of organisations / persons involved in teaching GI issues, to make sure

that the different perspectives (technical, societal ...) and backgrounds (Computer Science, Geography, Engineering ...) of these organisations are represented.

At the AGILE 2012 preconference workshop "Views on Body of Knowledge" (VoB) the "BoK2" initiative was presented (Ahearn, 2012) which includes a complete different approach compared to the existing BoK ("BoK1"). As BoK1 was in line with the general body of knowledge concept and presented a collection of content (knowledge areas, units, topics, themes) in form of a text book, the BoK2 project includes foundational research related to the BoK. This research includes ontology as a base to handle e.g. taxonomies and to be able to map different content. A semantic wiki and sophisticated visualization tools are also included in this research. In a later stage a platform will be developed which allows for a tool based handling of the BoK. It is planned that through this platform experts in GI can contribute to the further development and maintenance of the BoK. For more details related to BoK2 refer to (Ahearn, 2012).

## TASKS IN CURRICULUM DESIGN

Curriculum design includes quite a number of levels and also of tasks from the planning of a study program down to the planning of a lecture. An overview on these levels and on different approaches can be found in [Painho et al, 2006] and in the literature given there. This paper will focus on the planning of the content of module units and lectures. As already described in [Reinhardt, 2011] the authors had to define new GI related modules in different study programs like Computer Science, Information Systems and Civil Engineering. The challenges within this were the different background and study goals of the students as well as the different number of ECTS credit points dedicated to the GI related modules. More details on these issues can be found in [Reinhardt, 2011]. The structure of our study programs is included in figure 1. The lecturers are in fact responsible for designing the module level and below; up to lecture level and the program coordinator on the other hand usually taking care of the rest of higher levels.

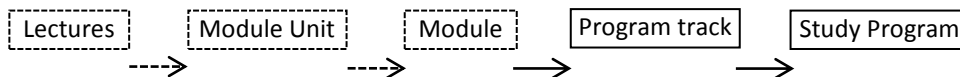


Figure 1: Structure of a study program

Only the lectures, module units and modules are dealt here in this paper. The ECTS credit point for a single module usually varies in a range of 4 to 10. The modules in general consist of two or more – but very seldom more than three - module units. Module units consist of around 12 lectures/exercises/seminars with 90 or 135 minutes each. To define the content of lectures and module units a number of considerations have to be taken into account, for example:

- The background of the students
- The goals of the study program / program track
- The number of credit points dedicated to the module unit

Along with the above mentioned considerations, the knowledge depth for each lecture has to be determined. There are three defined levels of depths.

- to know about it
- to be able to apply it
- to be able to implement it (especially GI methods/functions)

The planning of the content of a module unit can be performed based on a list of possible topics to be taught which could be the BoK or parts of it. From these topics the concrete topics have to be chosen considering the items explained in this section (background, goals, and credit points) and have to be assigned to lectures. To support this tasks a software tool was developed, which should include the following functions as a minimum:

- The possible content of GI education should be stored in a suitable structure in a data base. It should be possible to extend the content. For reasons of simplicity the BoK – and its general structure - was used as a base. The SDI extension of the BoK described in section 2 was incorporated.
- The content of the data base should be visualised to be able to view the content graphically.
- Also queries related to the content should be supported.
- The definition of the content of a module unit (or of lectures) should be supported. Therefore a graphical selection of content and an assignment of content to module units / lectures are necessary. The content of a module unit has to be stored in a defined structure in the data base to be able to present it graphically and also to modify or update it.

## A SOFTWARE TOOL FOR CURRICULUM DESIGN BASED ON BoK

Since the BoK follows a consistent hierarchy, it is possible to implement it in a database system for easy update and modification. This section introduces a new software tool which implements the BoK in a database system and assists one application of BoK among many. The tool as an initial attempt of automation covers only the curriculum design application area of BoK. Further application areas of BoK such as curriculum analysis, program evaluation and assessment, curriculum revision, program articulation etc. would be incorporated in the tool in near future.

### Design and Implementation of the Tool

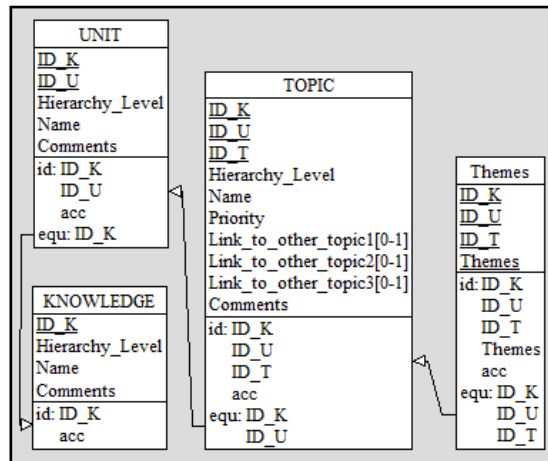
The architecture of the tool could be compared with the three tier client-server architecture. The database of the BoK content resides in the data tier while the GUI or user interface acts as client which executes the functionalities through application or server tier. So the three tiers are: data tier, server or application tier and client tier (fig. 2). The tiers are described below in more detail.



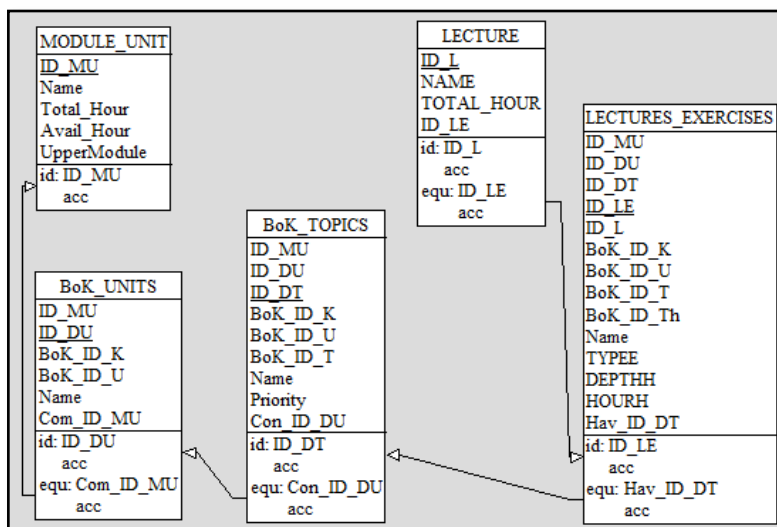
Figure 2: Simple architecture of the tool

The data tier contains the database of extended BoK content and a template of project database. Those are in fact MS Access databases with .acldb extension. Modelling of those databases has been done with DB Main - a free data modelling and data architecture tool. Figure 3 shows the data model of both databases. The consistent hierarchical nature of BoK content imposes a simple but very steady design of its data model. The superior hierarchical class is always related with its subordinate class by one to many relationship that means each Knowledge Area contains many Units, each Unit then contains many Topics and finally each Topic contains many Themes

The project data model on the other hand is almost identical with the BoK data model with a slide change. The LECTURE\_EXERCISE class which is in fact derived from the Themes class from BoK data model is the main class and related with two different classes: Lecture and BoK\_Topics with the relationship: many to one (fig. 3). The rest of the classes follows BoK data model in a similar way.



Bok data model



Project data model

Figure 3: Data models

All the program, queries and data technologies reside in the application/server tier. The Visual Basic .NET has been used as a programming language, SQL as a query language and ActiveX data object for .NET (ADO.NET) as a data object. The main task of the application tier is to process the commands from client as well as to provide the output to the client by making connection to the appropriate database, data retrieval and data modification etc.

The client tier contains the graphical user interface of the tool and some graphic modules to show the outputs from the application tier in a more meaningful ways. The graphical user interfaces (GUI) as well as the graphics modules are also programmed by Visual Basic .NET. The users in fact send different commands to the application tier and get visual outputs through the GUI.

## EXAMPLE OF THE USAGE OF THE TOOL

The tool has mainly four basic functionalities. They are: BoK database modification, data query, graphical presentation and navigation of the database and course/curriculum design. All the functionalities are described below in more detail with necessary screen shots.

## BoK Database Update

The first two sections of this paper have already described the need of a new extension of UCGIS S&T Body of Knowledge. It is, therefore, expected that the content of BoK cannot be considered as static but rather would be modified over time in form of content addition, deletion and modification. To make such kind of modification easy, BoK tool incorporates a data modification interface through which a user or respective authority can easily add, delete or modify any content area of the BoK. Obviously, the process of modification of BoK content should be systematic and could be done in many possible ways like Wiki, cloud etc. But this is another research question and is not the scope of the present paper.

## BoK Database Query

The query interface enables the user to see any content area of the BoK in textual form based on its uppers hierarchical element. To be more precise, user can see all the Units that belong to a particular Knowledge Area, all the topics belong to a specific Unit and all the Themes belong to a specific topic. This interface helps the user to navigate through the BoK content in an easy interactive way. A screen shot of the interface is given below by figure 3.

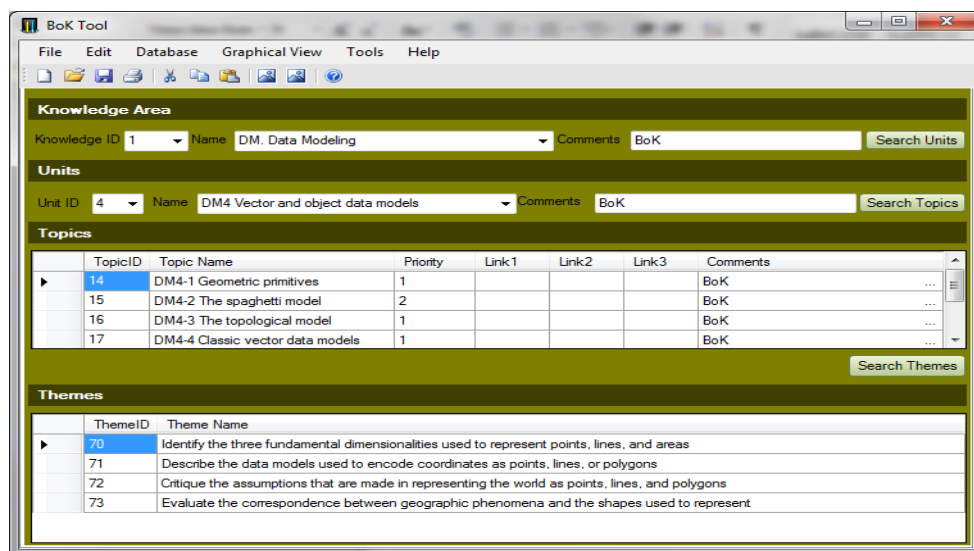


Figure 4: Data query interface

## Graphical Presentation and Navigation

This interface has been designed to provide a complete overview of BoK content as well as to enable users to navigate through the BoK content graphically but at the same time keeping other content in the view area to understand the relationship of each element with others. A screenshot of the interface (generated for test purpose) is given in figure 4 which in fact covers a small portion of BoK content.

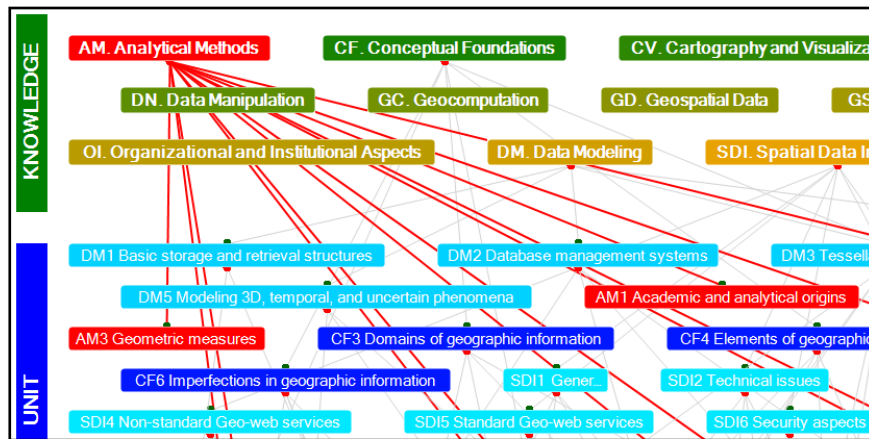


Figure 5: Graphical presentation and navigation interface

The interface draws all Knowledge Areas, Units, Topics and Themes of the BoK in a defined location. The relationship between BoK elements are further shown by straight lines. Thus a straight line between a Knowledge Area and a Unit means belonging of that Unit to that particular Knowledge Area. Since there are a lot of elements of BoK to be shown in the graphical presentation, the outlook of the interface becomes a little obscure and difficult to navigate. A number of techniques have been implied to overcome those difficulties. Firstly, different colour schemes have been applied to different hierarchy of the content which makes a clear distinction among them. In addition, a horizontal change of colour is applied to each hierarchy to distinguish each element in the same hierarchy. Secondly, the mouse over event changes the colour of each element to its upper hierarchy element. Finally, the mouse click event on any element highlights all related elements and paths in red colour. A knowledge element was clicked before taking the snapshot of the interface. As it is shown in figure 4, all the subordinate units and the straight lines of relationship are highlighted.

## Curriculum Design

As stated earlier, the tool implements one application area of BoK which is curriculum/course design. The interface/GUI is shown by figure 5. The black left window is the navigation window, shows all the knowledge areas chosen by the user with their respected units and topics. The grey area on the right hand side is provided to keep the course information that a user used to design.

Design of a new course starts with finding lecture/exercise topics which are comparable to the themes of BoK. The themes that sound suitable and appropriate for the course can be dragged and dropped in the navigation pane: Lecture/Exercise topics (fig.5 right part). In this way the user can chose as many lecture/exercise as they want from all topics shown in the navigation window. Each lecture/exercise topic should be further specified by three attribute that express whether it is lecture or exercise, how depth the student should learn about the topic and allocated time for that topics. The final step is to make a group of lecture/exercise topics in to lectures. All the lectures defined by the user through grouping lecture/exercise topics are listed in the 'Lectures' navigation pane (fig.5 right part) The users have also the opportunity to get an overview about BoK topics and units which are coved by the course. The navigation pane 'BoK Topic covered' and 'BoK Unit covered' serves those functionalities.

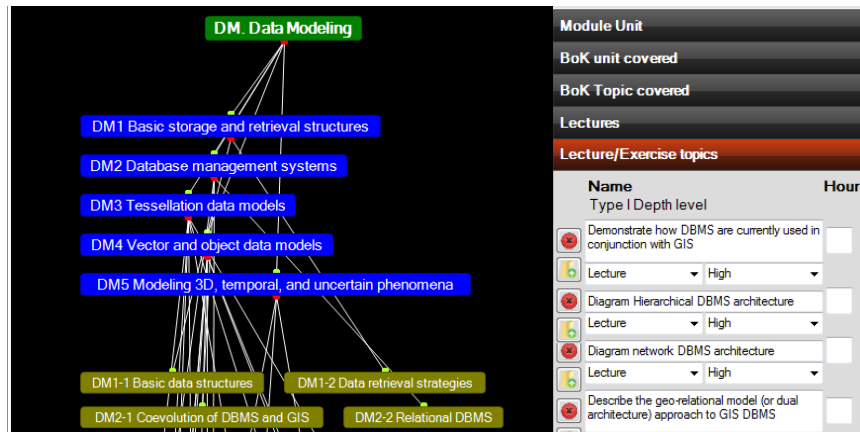


Figure 6: Curriculum/course design interface

Once a course design is complete the user can see the graphical representation of the course. An example (part of whole screen) of the graphical representation of the course is given by the figure 6 below. The figure shows that the course module ‘Database’ is composed of three lectures (green boxes), each lecture are further composed by several lecture/exercise topics (blue boxes) and so on.

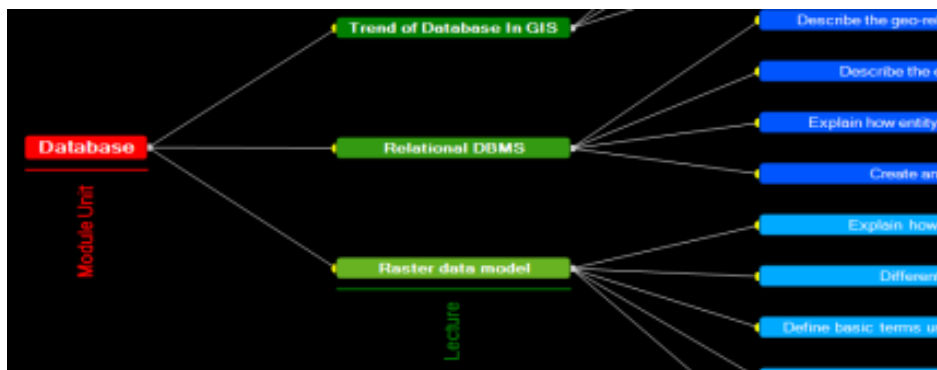


Figure 7: Graphical output of a designed module unit

## CONCLUSION

Some issues related to curriculum design based on an extended BoK have been discussed in this paper and a software tool have been presented to support some tasks of designing the content of module units and lectures. The usage of such a tool makes the planning of the content of lectures /module units more easy as it uses a data base with possible content for GI education, e.g. the BoK and allows for a graphical selection of content . Of course many extensions of this tool would be possible and useful, for example to include not only hierarchical but also general relations to be able to link units/topics. Another possible extension would be a web interface which allows students to view the content of module units to support their decision of module chooses.

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