DEVELOPMENT OF E-LEARNING MODULES IN SPATIAL DATA MANAGEMENT

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SUMMARY:
GI Science is as well as many other scientific areas characterized by an increasing volume of information and a decreasing validity of knowledge at the same time. This trend requires new learning methods using tools for visualization of learning content, which then heighten effectiveness of knowledge acquirement. In that context, buzzwords like e-learning, blended learning, lifelong learning or multimedia has appeared and a large number of GIS e-learning projects resulted from this development. The latest example is FerGI (Fernstudienmaterialien Geoinformatik - engl.: distance learning material for GIS), which will be introduced in the beginning of the paper. We then highlight the didactical as well as the technical aspects of developing e-learning-Modules in Spatial Data Management and conclude the paper with the results evaluation of the first module.

1. INTRODUCTION

The management of spatial data has gained more and more importance. Emerging object-oriented spatial database systems and servers, new OGC and ISO standards and different types of web services are indicators of this trend. Therefore, spatial data management is an important part of any GI curriculum and of most GI e-learning initiatives like the FerGI-project. The following section describes the organisation and the goals of this project.

2. THE FERGI PROJECT

The FerGI project started in October 2003. The aim of the three years lasting project will be to produce and evaluate 18 e-learning modules. These modules will not reflect the whole GI curriculum, but concentrates on special GI topics. Dividing the whole content into small compact modules (with ECTS points from 0.5 to 3) guarantees a better content exchange and a greater acceptance amongst GI lecturers (Schiewe, 2004). The contents of the modules will be given in German and / or English.

FerGI is a cooperative project of the Center of Excellence in Geoinformatics in Lower Saxony (GiN) and the e-learning network VIA Online. The GiN partners – five institutes from the University of Hanover, the University of Osnabrueck and the University of Applied Sciences in Oldenburg will develop the contents whereas VIA Online, represented by the University of Hildesheim gives didactic support.

2.1 MODULES IN SPATIAL DATA MANAGEMENT – CONCEPTIONAL ISSUES

The FerGI modules on spatial data management are mainly provided by the Institute for Applied Photogrammetry and Geoinformatics (IAPG) in Oldenburg. Altogether, five modules about spatial data management are intended. Figure 2 gives an overview of these modules and the connections between them. The size of the modules ranges between 1 and 3 ECTS points. Three of the modules are building the foundation of the other two, more application-oriented modules. Especially, the module “Standards for Spatial Data” is required or at least useful in many other GI modules.

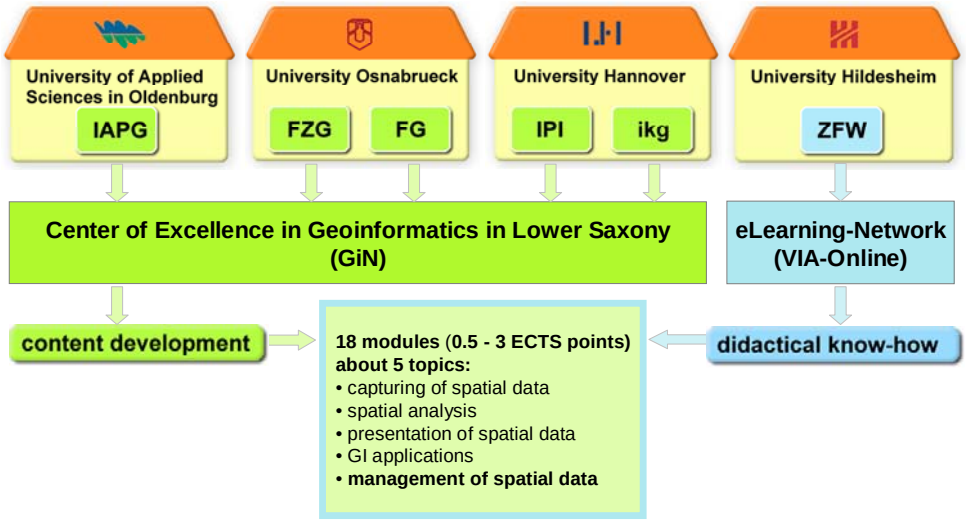

Figure 1: Organisation of FerGI.

2.2 TARGET GROUP AND PRACTICAL EXERCISES

In order to produce a sustainable solution with high effectiveness, e-learning projects have to consider several aspects. An early definition of the target group and of the project aims is essential in order to avoid conceptional changes, which can be extremely costly. The module of the topic “spatial data management” will be used for teaching students of geoinformatics, geodesy, geography and environmental sciences. Blended learning at universities, i.e. a combination of long-distance learning and face-to-face learning, is the main application case of the modules. In a second phase, it is intended to expand the target group to participants of further education programs.

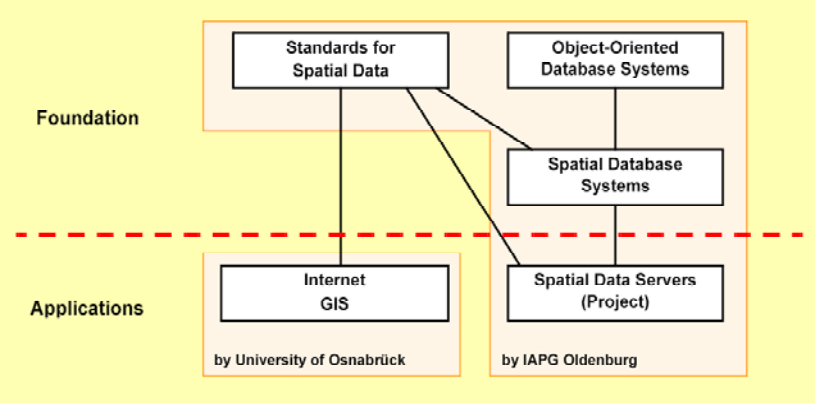

Figure 2: Modules about spatial data management.

In order to motivate learners over a longer period of time and to consolidate knowledge, the modules are particularly connected with practice. Studying with the modules should enable the student to develop competence on cooperation, self control and multimedia usage, which is essential with web-based learning methods.

2.3 MODULE CONTENT

Two of the modules developed by the IAPG Oldenburg, “Standards for Spatial Data” and “Spatial Database Systems” are completed and have already been integrated into lectures since September 2004. They are described in detail in the following paragraph.

The course “Standards for Spatial Data” consists of ten chapters starting with an introduction to data modelling. Afterwards, the basics of describing data models will be explored; in that context plenty definitions of terms like objects, classes and relations between objects are given in order to explain object-oriented modelling concepts. In addition, UML class diagrams are introduced in that section. Then, the course provides an overview of organisations for standardization of spatial data such as ISO/TC 211 and OGC. Three chapters present information about the Feature Geometry Model (Geometry and Topology package) and the Simple Feature Model. Both models are the foundation of the Geography Markup Language. The chapter on GML includes a short introduction to the basics of XML. Finally, the ISO standard 19115 “Geographic Information: Metadata” is topic of the last chapter.

The second course “Spatial Database Systems” focuses on the management of spatial data in databases. The introduction consists of a presentation and discussion of different techniques to store spatial data and of the concept of object-relational spatial database systems like the Informix Spatial DataBlade and Oracle Spatial. Then, the course provides an overview of standards for representing spatial data in databases including a short repetition of the Simple Feature Model and an introduction of the ISO standard SQL/MM Spatial. Oracle Spatial is presented as an implementation of such models. In this part, students can exercise spatial data modelling by using a special spatial SQL tool (see also next section). The last part of the module treats spatial query processing. Several techniques are introduced including approximations, quad trees, and r-trees. Again, students can exercise with Oracle Spatial and the spatial SQL tool.

2.4 MODULES IN SPATIAL DATA MANAGEMENT – TECHNICAL ISSUES

All FerGI courses present themselves in a unified layout using the same icons, font sizes and colors in order to give students a familiar setup. The design is based on an HTML template using a central Cascading Style Sheet (CSS).

Figure 3: HTML template with CSS stylesheet.

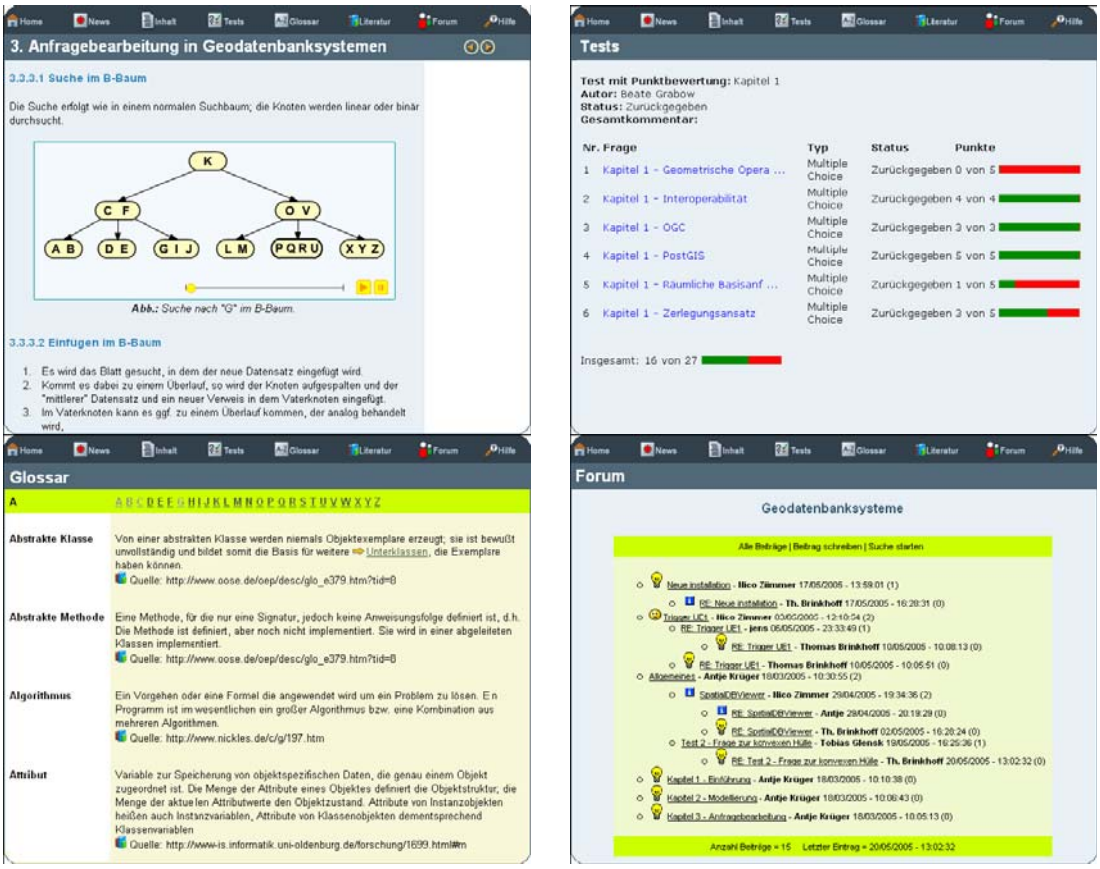

Figure 4: Screenshots of the module "Spatial Database Systems".

2.5 ANIMATIONS

Animations are very helpful for explaining complex learning contents. By using animations deliberately, the time of learning can be shortened and the comprehension can be increased. Since it is fairly time-consuming and costly to produce them, it is advisable to analyse deeply the effectiveness of using animations. Sometimes a single picture can express the same content as good as an animation, but producing it is much faster and cheaper.

2.6 SPATIAL DATABASE VIEWER FOR EXERCISES

As mentioned before, theory lessons should be tightly connected with exercises. In case of standard database lectures, this is typically achieved by (web-based) SQL interfaces; examples can be found in (Kudraß 2003). Using such an interface, the user can enter an SQL statement. After that, he gets an alphanumerical result – typically the query result (i.e. a relation) or an error message. In case of spatial database systems, such an approach is insufficient because the contents of tables as well as the results of queries may include spatial attributes. A textual or numerical representation of spatial data is difficult to interpret. In consequence, students would have difficulties to decide whether the SQL command or query computes the right result or not. In order to solve such problems, a spatial SQL Tool – the so-called "Spatial Database Viewer" – has been developed.

This tool allows the formulation of SQL statements. In addition to standard database tools, it

- supports the visualization of the (complex) structure of system- or user-defined objects,
- visualizes the content of tables with spatial attributes by displaying a map,
- visualizes the results of spatial queries (i.e. spatial attributes as well as the results of spatial operators) by a map, and
- depicts metadata of spatial attributes.

The visualization of tables and maps will be updated if a database update is performed using the Spatial Database Viewer. Spatial attributes of selected objects are highlighted in the corresponding map. The tool supports a German as well as an English user interface. Currently, it works for Oracle Spatial (Oracle, 2003a), release 9 and 10. Figure 5 illustrates the visualization of a spatial table, of a complex spatial attribute and of spatial metadata. The visualization of the spatial buffer operator is depicted in Figure 6.
The Spatial Database Viewer is implemented in Java 2 Standard Edition, v1.4. It runs as a standalone application as well as a Java applet. Oracle's JDBC library (Oracle, 2003b) and SDOAPI library, the Java Topology Suite (JTS 1.4) (Vivid Solutions, 2003) and the Oracle Spatial library of (Geotools, 2004) are used. The principle steps for performing a spatial query are depicted in Figure 7.

3. EVALUATION

In December 2004 the first module "Standards for Spatial Data" has been evaluated by about 20 students at the University of Applied Science in Oldenburg. Although these students had not yet worked with e-learning content, they found the module intuitionally accessible and most of them were convinced that the presented media was more motivating compared to a traditional lecture. Furthermore, most students liked the idea to use such modules to support

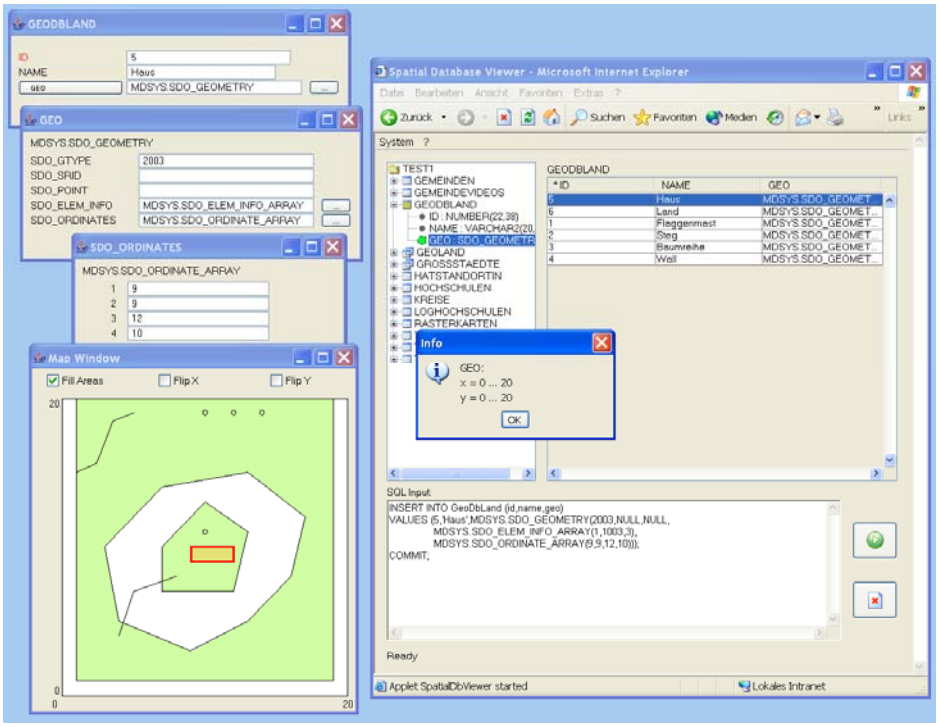

Figure 5: Visualization of spatial tables, complex attributes and metadata by the spatial SQL tool.

face-to-face-lectures, but not to substitute those. So FerGIs aim to develop modules for blended learning usage was the right choice. Concerning flexibility in time and place and the effectiveness of learning, there was a definite positive tendency.

4. CONCLUSIONS

In this paper, we presented the FerGI-project with its conceptional design and technical issues for developing e-learning modules about spatial data management. Up to now, two modules have been integrated into lectures. The current feedback of students in the discussion forum and the results of their tests were positive and show a broad acceptance of the courses. Finally, it will be important for the success of FerGI to develop a business model for the time after the end of governmental funding in September 2006. To finance further e-learning activities, a co-operation of FerGI with other GI e-learning initiatives in Germany and Europe would be necessary.

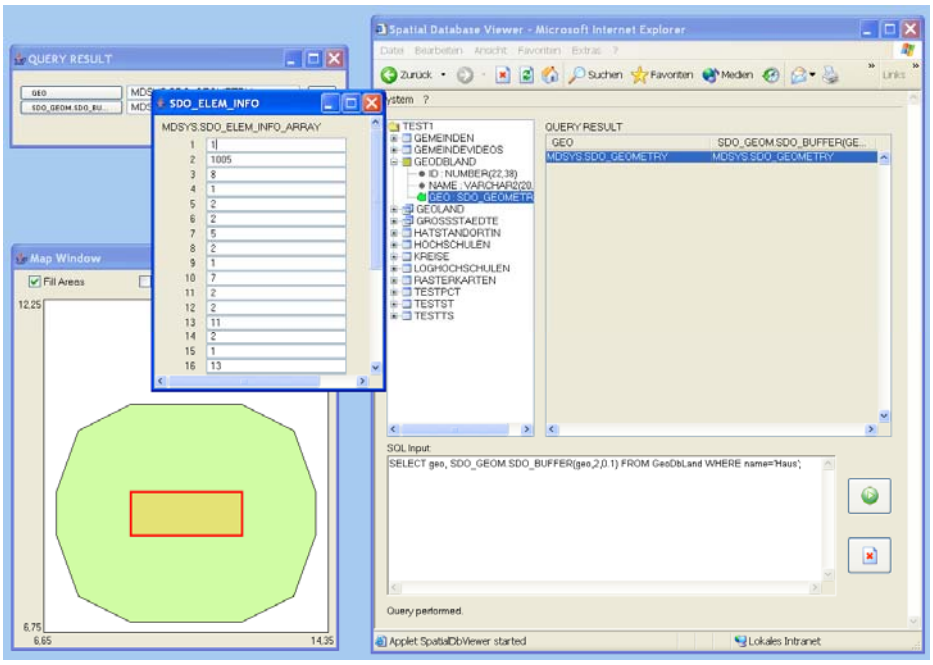

Figure 6: Visualization of the spatial buffer operator by the spatial SQL tool.

5. ACKNOWLEDGEMENTS

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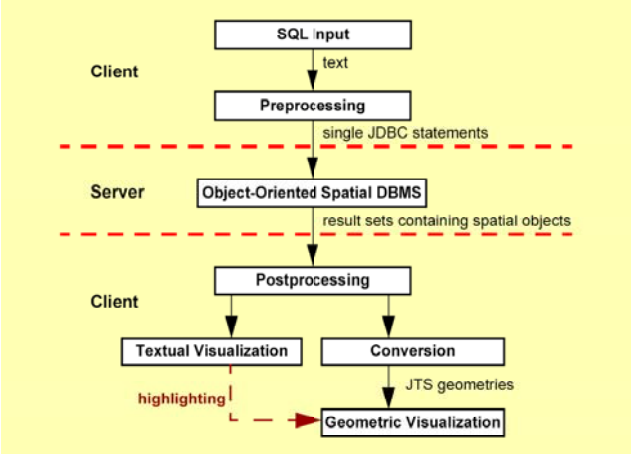

Figure 7: Processing of spatial queries by the spatial SQL tool.