VISUM: VIRTUAL SEMINAR FOR EDUCATION IN MATHEMATICS

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ABSTRACT

VISUM - the (VI)rtual (S)ystem for Ed(U)cation in (M)athematics is a fast growing knowledge base containing material about teaching mathematics (URL: http://visum2.uni-muenster.de). The project is funded by German ministry of science and education with 1.6 Million Euro and will cover mathematical as well a didactical content for the education of student teachers from primary to higher secondary level. Mainly written in German, the content will be translated into English in the coming years. When preparing knowledge for presentation in an Internet based multimedia system, special methods are needed to avoid - for instance - the "lost in hyperspace"-problem. The designer's answer to this problem is the so called Object Oriented Theme Analysis (OOTA) which is based on ideas coming from computer science, but adapted to the analysis of didactical knowledge about certain topics (e.g., arithmetic in the primary level, working aids, ...)

The lecture will present this method, give a survey of the constructivist background of the system and the role of media (video, audio, ...) in the system, and show examples. The VISUM software creates a navigation platform, which can be used as an authoring tool by universities world-wide - at the time of the conference there will be an online authoring tool for this purpose available. So, the lecture will contain an invitation to take part in the creation of a world wide network for teacher education in the field of mathematics.

1. Introduction

In the area of teacher education in mathematic s videos have been used in lectures and seminars for a long time. Showing sequences of lessons or interviews with children after activities of problem solving are examples for the concept of *situated learning*. Working with such authentic material has the intention:

- to illustrate didactic theories or strategies, and
- to present a starting point for the examination of learning processes.

Multimedia systems offer additional possibilities to approach didactical content by using animations, audio and video sources. Researchers started examining the new facilities in teachers education in the middle of the nineties.

The CD-ROM *Learning about Teaching* (*=LAT)* (Mousley & Sullivan 1996), introduced by P. Sullivan at the PME conference in Lahti (Sullivan 1997) is an outstanding example how to embed questions of the lessons design and analysis in an learning environment with video recordings and transcripts. By these means student teachers can approach theoretical concepts by examining authentic material with a focus on didactical questions. A video of a lesson together with a lesson plan is one example of authentic material. Authentic documents of children demonstrating a problem solving process is an other source for the student teachers.

At the end of 1998 M. Stein took this CD as a starting point for the VISUM project to use the new multimedia facilities for teachers education in mathematics in Germany. Beside the production of multimedia content for teachers education there are three basic aspects showing the differences between the *LAT-CD* and the VISUM project. .

- no limitation to a fixed commercial authoring tools (the *LAT-CD* was developed with *Authorware*),
- strong focus on developing a concept of Internet based learning, with a platform which facilitates at the same time the distribution of content on CD-ROM without a Webserver,
- presentation of the methods to generate hypermedia content from linear text information,
- the production of didactical and mathematical content is part of the educational concept. This means that VISUM is not only a learning environment with multimedia material *(LAT-CD),* but the project encourages *student teachers to produce multimedia documents* in private areas of VISUM. The learning process for the student teachers during the production of didactical content is one main aspect of the educational concept of VISUM.

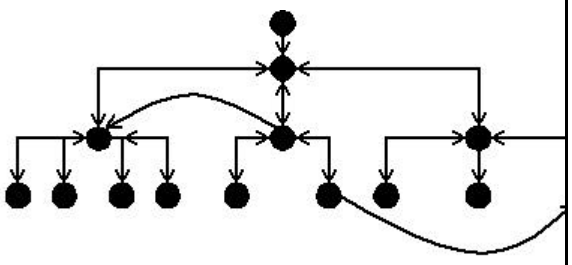
Objective: *The objective of VISUM is the Internet based production and presentation of didactical and mathematical knowledge. The issues are a knowledge base and a method of content generation to embed the production of multimedia content in the educational concept for student teachers. .*

Since 1.1.2001 four working groups (Th. Weth, Erlangen, H.-G.Weigand Würzburg,U. Tietze, Braunschweig, M. Stein Münster) are joining the VISUM project focussing on different mathematical and didactical aspects in primary, lower and upper secondary teachers education. This project is funded by the German ministry of science with 1.6 Million Euro.

2. Knowledge Representation

Knowledge representation is one part of the objective of VISUM. The following section describes the structure of the knowledge base, in which the mathematical and didactical content in VISUM is organised.

The basic supposition of the didactical and mathematical knowledge in VISUM is that the known scopes of teacher education can be represented in a structured way. The arising structure is organised in the shape of a directional tree.



Picture 1: directional tree

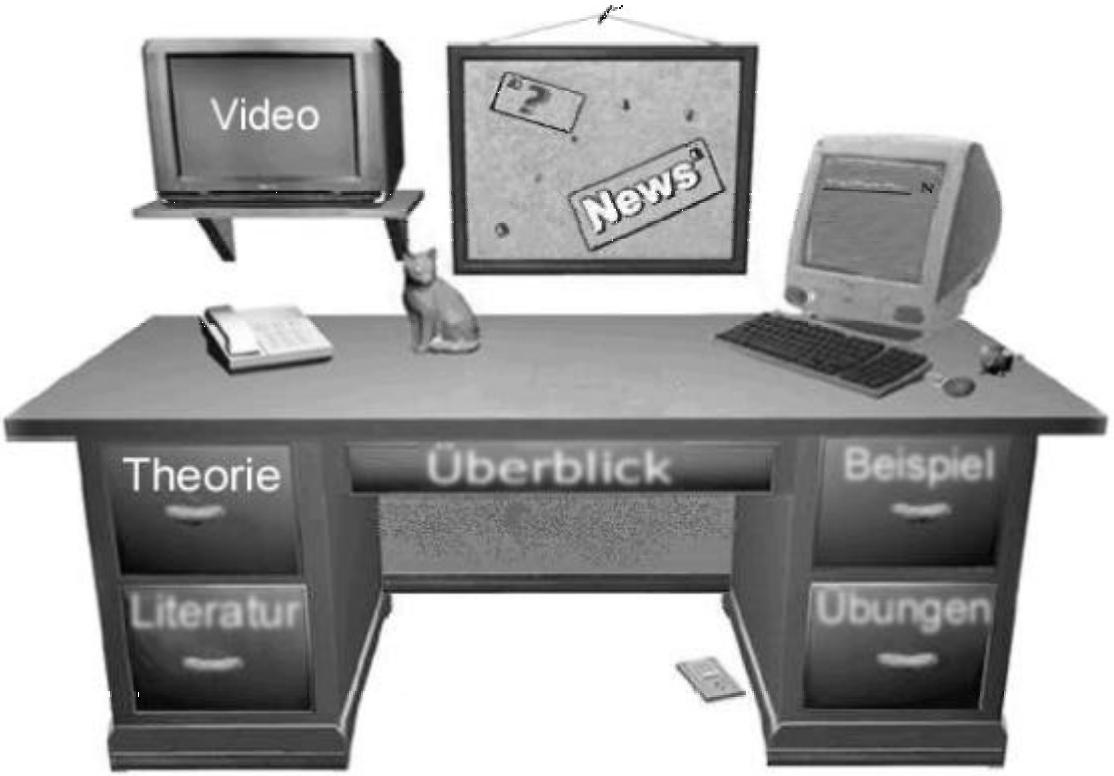
Picture 2: menu of the tree

In the general case, the arrows can be represented as hypertext links, connecting one information with an other information. In VISUM these links are not simple hypertext links, because the nodes in the tree represent a *collection* of different types *of information* (HTML-pages, video, audio, animations, ...) for a special subject. If we take as subject *"Ruler in Geometry"* this collection contains for example

- a *video* of a geometric problem solving activity with a *ruler* (recorded in a classroom),
- a collection of tasks for children in primary schools using a *ruler* as a tool,
- *tasks* for student teachers to analyse the geometric problem solving activity of children with a *ruler*,
- *Internet links* to the subject *"Ruler in Geometry"*, e.g. to geometric problem solving activities with a *ruler* in lower secondary schools,
- *theoretical* background information to the applications of the *ruler* in primary schools.
- additional *literature* references to the subject *"Ruler in Geometry"*,
- *news*, e.g. "conference July, 25., 2002 in XY -Title: Geometry in Primary Schools"

So a link between tree nodes in VISUM is a link from one collection of information to an other collection. Now we need an interface for this collection of different types of information. In VISUM we chose a Desktop as metaphor.

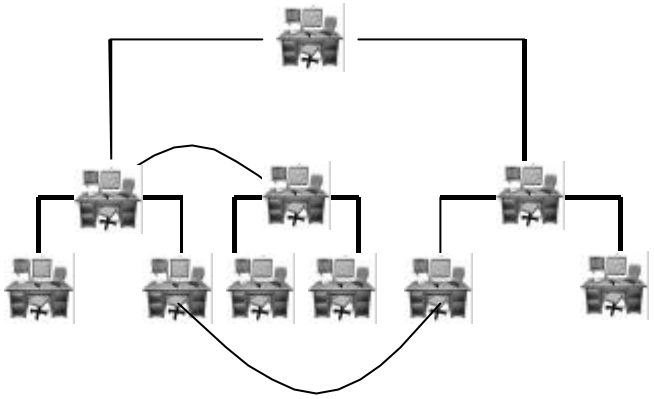
Ruler in Geometry



Picture 3: Desktop for the content "Ruler in Geometry"

In the illustration we see the “desktop”-interface representing the collection of information to the subject *Ruler in Geometry*. Some drawers are highlighted for example with a title *theory* (German "Theorie") and *video* (German ”Video”). This means that the desktop provides *news*, *help*, video and theoretical information to the subject *Ruler in Geometry*. Some information categories are not highlighted because they are not available. Normally every *tree node* respectively *desktop* should contain these different types of information, so that the user can choose an individual approach to the subject *Ruler in Geometry*.

This provides a tree structure with desktops as nodes.



Picture 4: Content in the desktop depend on the tree node

So when a user is navigating from one collection of information to an other collection the desktop with the drawers is filled with *hypertext, videos, links* and *references* according to the subject the user is looking at. This *context dependency* of the desktop has the objective that the user will only get the information of a chosen subject (e.g. only literature references and videos to subject *Ruler in Geometry*). This means that the user can access the video screen only, when there is a problem solving video to the subject *ruler* offered from the author.

The basic idea of the *VISUM context dependent knowledge representation* is, that the desktop *classifies the information*. The following attributes show the chosen types of information in the VISUM system:

Survey: presents a short description about the respective subject, which could be used as an introduction containing hints for user to start with -- drawer in the middle,

Theory: the didactical or mathematical theory about the respective subject of the desktop -- drawer on the top left,

Examples: the examples are used as an illustration for the theory -- drawer on the top right,

Literature: References -- drawer on the bottom left,

Activities: Exercises for the student teacher according to the subject of the desktop -- Drawer on the bottom right

Video: Videos and animations -- monitor on the left

News: scheduled events according to subject of the desktop, -- News sign at the board in the middle,

Links: Internet links -- monitor on the right,

Help: gives advice for solving problems in the *Activities* drawer -- Help sign at the board in the middle.

Contact: presents the e-mail address of the author or the tutors of the lecture/seminar -- telephone on the desktop.

3. Internet Based Didactical Concept

At first sight it seems to be sensible that only didactical and mathematical experts should work on the construction of a knowledge base. But one step further the didactical concept of VISUM offers the embedding *of content generation* in the process of teacher education. This means that student teaches produce web pages and multimedia material for an information system, which serves e.g. as a basis of

discussion in seminars. With this approach the student teacher swaps the *receptive role* with the *constructive role* of a content generator. This process is embedded in lectures, seminars and the homework of the student teachers for their examinations. The following three items illustrate the process from the receptive to the constructive role of a teacher student.

receptive - In the *lecture* material of VISUM, like animations, videos and HTML-pages, are used for the presentation. After the lecture the student teachers can access the information online. The sources of the lecture are embedded in a knowledge base, so VISUM offers additional information according to the subject of the lecture. By this receptive work the student teacher gets an idea of the knowledge organisation in the information system. Teacher students should learn to navigate and retrieve information for the lecture from VISUM.

receptive & constructive - in a *seminar* student teachers get a first contact with the content generation in VISUM. The VISUM system is designed in a way which demands (nearly) no technical knowledge for the construction of web based information, so that the didactical concept can focus on the *organisation* of web based content and the *structuring of mathematical and didactical knowledge*. Beside the fact that the work of the students is presented in a closed area of VISUM the student teachers had to *integrate their content* into the existing information system of VISUM. The individualised information system of the student teacher combines personal material with material of the official VISUM information system. For this combination of personal area and the official expert content the student teacher has to explore the VISUM information system for helpful connections (links) to the subject of the seminar. This includes major *receptive work* with VISUM.

constructive - student teachers get the opportunity to write a *homework* for their *examination* within the VISUM project. This homework consists of the construction of a *product* and a *theoretical text*. The *product* is a VISUM knowledge base about a didactical subject (for instance: practise in arithmetical lessons), the *theoretical text* describes the principles of collecting knowledge and preparing it for use in the knowledge base. This type of homework is very attractive to our students since they know that – good quality the product assumed – the product will be made accessible to other students via the Internet, as part of the VISUM project.

The following section tries to give some rough ideas how the method of analysing knowledge for presentation within the VISUM system works.

Object Oriented Analysis (OOA):

Object Oriented Analysis is a problem solving strategy developed in Computer Science. Despite of the fact that this strategy has its origin in Computer Science, it is a modelling concept *strictly independent* of a programming language. The *VISUM method of structuring knowledge* applies basic ideas of OOA to *structure knowledge* (for instance, about didactical subjects like *ruler in geometry*). It analyses a system and decomposes it into objects that are found in the system. *Decomposition* is one principle of the OOA, so that all objects can be decomposed in subobjects again. The process of decomposition provides the tree structure which was shown in section 2.

Beside the decomposition, the *objects are classified by properties they have in common*. So *classification* is another principle of the OOA. The relationship between Theory, Example, and activities (see section 2) is one derivation of the classification principle within the VISUM system – the desktop is the metaphor for this classification.

The upper mentioned decomposition defines a *relationship between the objects*. Beside this relationship the OOA model contains *associations between objects*. For example, the OOA model could contain an *association* between the *problem solving strategies in geometry* and *psychological aspects of problem solving*. These associations are represented in the VISUM system by a special type of link, so that every user can see the existing associations. So the arising structure is a web of objects organised in a tree.

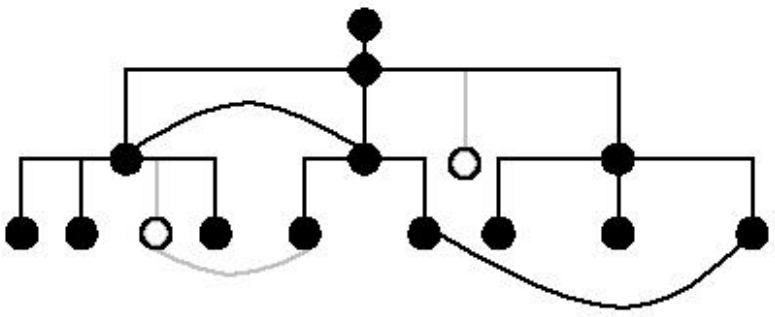
It is important to mention that a model, generated with the OOA, is dependent on the person, who did the modelling. Different views on a system generate different object oriented models.

In the process of using VISUM in lectures and seminars to developing material for VISUM as part of the final examination ("states exam") the *constructive aspects* of the student work increases, so more detailed knowledge for content generation is necessary. Students who wish to present their knowledge in the VISUM system as part of their final examination, have to visit special seminars in which they are trained to apply OOA to their special theme, and how to use the possibilities of *multimedia* for presentation in a web based system. The full method used in VISUM is the called *OOTA* (*object oriented theme analysis*) and described in Niehaus 2002 and Ernst, Stein 2002

Of course not all students write their homework in mathematics and didactics or get in contact with VISUM in lectures and seminars. The main focus in the developing of the didactical concept is the consistent embedding of VISUM in the education of student teachers at the university. This leads to a ***constructive competence of structuring didactical knowledge and didactical problems***. On the highest level the issues of the student work could be presented within the official VISUM information system or it could be used as a basis of discussion and further development of the students.

4. Individualisation of Knowledge Representation

In the preceding sections we focused of on the VISUM knowledge representation. Keeping the constructive aspects of the didactic concept in mind, it is necessary that students can participate in the *construction process* of VISUM knowledge without modifying the public accessible knowledge base. In the following picture we can see black tree nodes and white tree nodes symbolising one single desktop. The *black nodes* with the black lines symbolise the public accessible knowledge base with the connections between the desktops. The *grey connections* and the *white nodes* symbolise a *private modification* of the public knowledge base. The private modifications characterise an *individualisation* of the knowledge representation.



Picture 5: White nodes and grey connections symbolize the individualisation in the tree

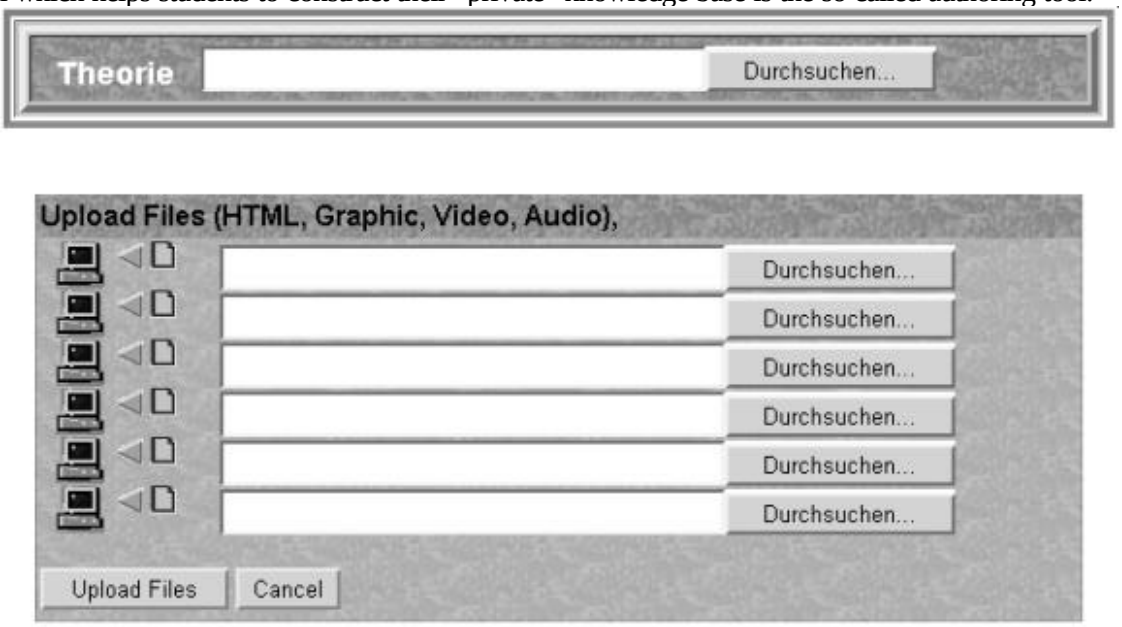
This aspect of *individualisation* gives the student teachers an option to integrate their own knowledge in a given official knowledge base. By the interaction between the *receptive* and *constructive* elements of the didactical concept the student teachers discover parts of the given knowledge base.

The private white nodes in tree represent for example an evaluation of geometric problem solving strategies of a teacher student *S* in the primary school *XY* about the application of the *ruler in the geometry lesson*.

If a *guest* is navigating through the mathematical and didactical knowledge base of VISUM, then the white nodes and the grey links between the nodes are *not visible* respectively *not accessible* for the guest.

Furthermore the visibility, the accessibility and the rewriteability of content can be extended from the author to special user groups (online workgroup of teacher students). This means that the private evaluations of a teacher students *S* in the primary school *XY* about the application of the *ruler in the geometry lesson* can be visible and/or rewriteable by the members of seminar *Z* about geometry in primary schools to serve as a basis of discussion.

The individualisation is also helpful for *teachers educators using VISUM in a lecture*. They can adapt the knowledge base to meet the personal requirements (focal points of the lecture). We should keep in mind that the *public official knowledge base* is in general not affected by this modification. The following picture shows a screen shot of the user interface of the authoring tool. As has been said before, the VISUM system is designed in a way which guarantees that student teachers can bring content into the system even with (nearly) no knowledge about the technical aspects of hypermedia and web-design. The tool which helps students to construct their “private” knowledge base is the so called authoring tool.



Picture 6: layout and design of the beta-version

With this interface a user can upload a HTML-file to the *THEORY-drawer* in one desktop of the VISUM knowledge base (top rectangle -- Theorie=theory). After the upload procedure the content is accessible in the *THEORY-drawer*. The Interface consists of two parts (top and bottom rectangle) because the HTML-file in the *THEORY-drawer* contains e.g. pictures and video files, which had to be uploaded as well. A click on *"Durchsuchen..."* (German for *"Browse..."*) provides the user with a file menu to choose the file

the user wants to upload (transferred files to the server). After this upload procedure the information is available in the *THEORY-drawer* of ***one desktop*** in the VISUM knowledge base (password protection).

This option of individualisation in the VISUM system takes two contructivistic aspects into account.

- The ***receptive aspect*** offers the user a knowledge base, in which the user can navigate to VISUM content she/he is interested in. This knowledge should be embedded in the individual structure of the users knowledge.
- The ***constructive aspect*** offers the user the option to modify the knowledge base according to the individual structure of the users knowledge without modifying the original content.

5. Summary

The preceding sections show that VISUM is not only a knowledge base but it stands also for a didactical concept, which supports the education of teacher students at the university. To realise the *receptive* and *constructive* aspects of the constructivistic approach it was necessary to develop guidelines for the knowledge representation in VISUM to support teacher students in the constructive parts of the content generation for VISUM. This concept started with the OOA was developed further to the OOTA (Research Project: A. Ernst, M. Stein). So one focus of VISUM is integrating student teachers in the process of content generation. Therefore a simple user interface of the authoring tool was a technical precondition for this integration.

The *classification* of information in the VISUM desktop structures the generation of sources in the VISUM knowledge base. For the teacher students the desktop provides a scaffold for the constructive aspect. The VISUM system guides the user from the *receptive work* (lectures) to a constructive work in the knowledge base (seminars, homework for the examination). The underlying idea of Constructivism together with the object oriented concept presents a didactical approach which breaks the borders determined by a knowledge representation of books. Leaving out the different access and visibility rights to the VISUM system, *expert user*, *author* and a *didactical novice* share and embed content in a knowledge base, which serves at the same time as a basis of discussion for the mentioned user profiles:

- for expert users examining work of teacher students and colleagues,
- for student teachers examining and discussing the content of expert authors and/or student teachers.

Keeping in touch with the didactic state of the art and contributing ideas is a basic objective for understanding of the dynamics of Internet based content.

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