
WAGENINGEN ADVANCED LEARNING SPACE IN GEO-INFORMATION SCIENCE

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ABSTRACT

Wageningen Advanced Learning Space (WALS) is a long-term project of the Wageningen University. The project aim is to define conditions for computer-assisted education and distance learning. Within this project attention will be paid to administration, registration, digital courses and examination. As part of the WALS project the Centre for Geo-Information and the Educational Institute of Technology and Nutrition have joint forces in order to define conditions for online courses. They have been studying existing Digital Learning Environments, but to be free of the possibilities offered by these learning environments, they have also built a Digital Learning Environment Demo using Microsoft FrontPage complemented with self-developed tools and freeware. At present several online courses are already available. Course material has been reconstructed into re-usable content objects and stored in a database.

It was found important to be able to re-use course content. Therefore it should be stored in small recognisable parts at a central place and described with metadata stored in a database. An Internet browser was found the best medium to present a digital course. Browsers are mostly free and usually installed on every PC nowadays. Although each course can be made location independent in such a way, one should be aware of the fact that students often cannot afford to buy software licenses for expensive GIS/Image processing programs. Therefore each course should contain a list with programs required to follow the course. It was found that a traditional book-chapter structure gives the student the best overview of the learning route. However, within one course there can be multiple learning routes. The course environment should be uniform in all the courses within one group. High click frequencies should be avoided. Students should be able to navigate from content to content or from content to learning route with as few mouse clicks as possible. Student-teacher and student-student interaction should both be well supported.

1 INTRODUCTION

Wageningen University & Research centre has a long-standing experience in the use of computers in higher education. Over the years the initially adopted control paradigm was gradually replaced by the currently predominantly information resource paradigm (Hartog, 1989). Wageningen Advanced Learning Space (WALS) is a long-term project of the Wageningen University. The project aim is to define conditions for computer-assisted education and distance learning. Within this project attention will be paid to all components of a learning environment, including administration, registration, digital courses and examination (WALS, 2000). As part of the WALS project the Centre for Geo-Information and the Educational Institute of Food and Biotechnology have joint forces to define conditions for online courses. Both groups have each year a number of MSc students from many different countries attending the courses. Therefore there is need for distance learning facilities. In the last years the possibilities of digital lectures, online courses, student-teacher interactions and efficient management of online courses as well have been exploited. Several systems for configuring and managing online courses with different types of content including audio-visual material have been developed and used. Also existing digital learning environments, like Lotus Learning Space, Next Generation Learning, OLA, Gentle, Eurocampus and others, have been studied.

2 DEFINITIONS

2.1 Digital Learning Environment

The basic function of a Digital Learning Environment consists of facilities for creating and maintaining courses by teachers as well as reading, browsing and search facilities for the students. Besides, a digital learning environment also supports functions such as:

- Administration and authorisation (who is allowed access to the course and at which level)
- Communication (contact between students and between student and teacher)
- Tracking (registration of student activities and individual progress)

2.2 Re-usable Content Objects

Setting up a course means that a number of individual “modules” or components to learn theories, methodologies, skills and attitudes have to be created or adapted. The possibility to use some of these components unchanged in another course is not only attractive but also more or less necessary. Such an individual component is called a re-usable content object (RCO). Each individual module becomes a re-usable content object if additional information about the educational function (learning objective, level, didactic form, etc.) and its history (author, source, keywords, type, date etc.) is added. Such metadata (Ariadne, 2000; IMS, 2000; WOLL, 2000) are useful and sometimes indispensable for retrieving the re-usable content objects. A special type of RCO is the composite RCO that it self consists of a structure of linked RCOs.

3 PLATFORM SURVEY

Existing digital learning environments such as Lotus Learning Space, Next Generation Learning, OLA, Gentle, Eurocampus and many others have been studied (Hartog et al., 1999). Digital learning environments can be distinguished into file-based systems and database applications:

- File system-oriented; simple learning environments use a file system to connect the course modules (documents) to each other. Such a system is easy to build but as it grows it becomes increasingly difficult to maintain. WebCT, TopClass, SWIFT, Referential Learning and to some extent FrontPage are examples of a file system based environment. (FrontPage is no a learning environment but a system that supports many functions for web management which are also indispensable in a learning environment)
- Database-oriented; more complex learning environments make use of a database and thus of a database management system as well. Such a database usually has two main sets of tables: first of all those tables that are directly necessary for user administration (including authors, instructors and students) and secondly the set of tables directly related to (storing metadata for) the re-usable content objects. The metadata attached to the re-usable content can be used by teachers to create a new curriculum or by the students to find additional information to complement their course. Exam results can be stored in a database and in the case of multiple choice automatically reviewed. Tracking, where pageviews and actions of the students are being stored in a database. Mercator, Ola, VCampus, Librarian, Keller, Lotus Learning Space and Next Generation Learning are examples of database oriented environments.

It was found important to be able to re-use course content. Therefore it should be stored in small recognisable parts at a central place. This requires that each content object be described by metadata in order to enable lecturers to search for components when building a new course and in order to support content retrieval by students. Furthermore, if the components are formed carefully they appear only once in the database. So, many courses (or learning routes) can use the same components. However, not everything in a course is re-usable. We regard the pages that are not re-usable (integrating texts, particular period-based schedules) as glue pages, they make a course built of RCOs run smoothly (see figure 1). Because of the use of a database we concentrated our platform survey on database

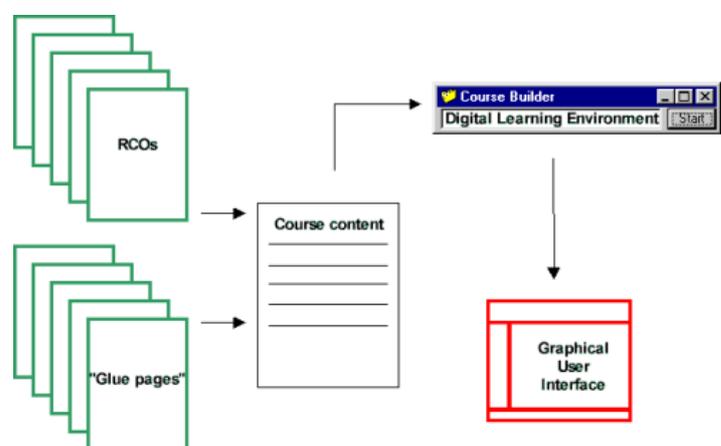


Figure 1: Course construction model

oriented environments. Based on the experiences we had with the evaluated learning spaces it was found that the student and developers interface should be time and space independent. Furthermore, access to the courses should be based on a centralised authorisation database.

4 RE-USABLE CONTENT OBJECT TYPES

Digital re-usable content objects can be stored in many formats, all with their own advantages or disadvantages.

4.1 Word-Processing or Presentation Files

Documents like WORD (doc), PowerPoint (ppt), Adobe Acrobat (pdf), WordPerfect (wpg) or Rich Text Format (rtf) all store their images inside the documents. Therefore those images can not be used in other documents without cut and paste by the author. Most Learning Environments use an Internet browser as intermediate between the course content and the students. To display word processing files in a browser often requires the program to be installed on your machine or plugins to extend the browser functionality. Often word processing files were written for printing, therefore they contain too much text and little or no user interaction. However, because all content is stored into one file it is easy to document and maintain.

4.2 Hypertext

HTML files in combination with other hypertext programming languages such as XML, ASP, JavaScript or Visual Basic script are dynamic and interactive media, which can easily create an interactive course module. Because images are stored separately from the text files they can also be used in newly formed text without having to store the picture twice in your file system. Even if the author decides to describe the text and images as one RCO in the meta database, another author can add additional meta information, which describes only a certain image from the original RCO. However, such hypertext RCOs are very sensitive to changes in one of the components. Moving or renaming an image (or text file) without updating the hyperlinks would destroy the RCO. If an author decides to use an image, which is already used in another RCO, without duplicating the image he has to be sure that the image won't be moved or renamed by the original author. Ideally one would want to separate presentation completely from text. In practice this is seldom realised.

4.3 Movies and Animated Images

Unless they are highly compressed, movies (avi, mpeg, mov, rm) or animated images (gif) may require prohibitively high bandwidths. Although movies can be very good to demonstrate certain actions, they often take a long time to download with a telephone modem. Unless the movies are streamed, it would take the student several minutes to receive the complete movie. Streaming assumes a certain modem speed so that the movie can be played before the download is completed. Most modem users at home nowadays have a 56Kbaud telephone modem. Streaming an audio-visual movie with the size not much more than a post stamp (160x120 pixels) still results in poor quality. Streaming often requires plugins installed at the students' machines. Therefore we decided to store all objects that require substantial bandwidth in a separate subweb which we distribute on CD-ROM or DVD when necessary, i.e. when the student does not have a high bandwidth connection.

4.4 Images and Geo-information Files

Documents, which are nothing else than large data sets to provide geo-information, can be handled in two ways. In the first place they can be downloaded to work with them in a (de)central processing environment (like ArcInfo or Imagine). The other possibility which is still under construction offers processing by Web based environments; the so-called Internet Map Servers (IMS). This latter one requires a learning environment that offers processing of such facilities too.

5 RE-USABLE CONTENT OBJECT SIZE

Each re-usable content object requires metadata. However entering metadata is expensive. Thus the question is: what is the ideal size for an RCO? To answer this question two approaches can be applied: a content based and a user-interface based.

If you decide to split a chapter into an RCO for each paragraph it becomes easy to retrieve your object. However, without meta information of the complete chapter as one composite RCO it will take a teacher a long time to reconstruct the RCOs in their original order. One or two screens with information in an RCO seem, from a user-interface approach, a promising guideline for text based content objects. This is about 350 - 700 words. In the meta information it should be

mentioned if the object is part of a larger group of objects. You can understand that such a detailed description requires some time investment. Experience with the object authors learned that it should be possible for an author to describe the objects only on group level (pages and images), but allow others to add meta information on individual files (page or image) inside a grouped object. Deciding on the size of RCOs is a matter of finding the balance between the cost of entering metadata initially and the benefits of easy retrieval of content later.

6 RE-USABLE CONTENT OBJECT VERSION CONTROL

Once an object has been placed in a database or fileserver it can be used in many courses. Therefore, such an object cannot be deleted or changed if it is used in a course. Minor changes like spelling should be allowed, but replacing or removing paragraphs or pictures could have large effects on existing courses. Therefore such changes require a new version of the document. Document versions should preferably be mentioned in the title of the meta information.

7 STUDENT GRAPHICAL INTERFACE AND NAVIGATION

An Internet browser was found the best medium to present digital courses. Browsers are mostly free and usually installed on every PC nowadays. Within a Microsoft environment, most browsers handle files of other applications such as WORD, Excel or any other program installed on a student's PC. Therefore not all the course material has to be adjusted. Although each course can be made location independent in such a way, one should be aware of the fact that students often cannot afford to buy software licences for expensive programs like GIS/Image processing programs. Therefore, each course should contain a list with programs needed to follow the course. Certain courses will only be suitable for the university Intranet.

After reviewing several learning environments, it was found that the student graphical interface should be clear and simple. Focus should be on the content area, so this area should be given maximum space. High click frequencies should be avoided. Students should be able to navigate from content to content or from content to learning route with as few mouse clicks as possible. Therefore "fast buttons" should lead to similar information in all courses such as discussion, glossary, acronyms, virtual library, tools, data sets etc. The "fast buttons" should always be available on the desktop and so should the learning route. It was found that a traditional chapter structure gives the student the best overview of the learning route (KELLER system, see hereafter). However, within one course there can be multiple learning routes. Students like to know where they are. Thus we try to offer our students a tree view of the course and highlight where the student is. Finally there should be some space for logos and course name. Logos and fast buttons should preferably be small and not animated so that the attention of the student is focussed on the content area. The course environment should be uniform for all courses.

8 EXAMPLES

At present several online courses have been built. A complete series of digital lectures was made (18 lectures Remote Sensing Basics) based on Real Audio and HTML streaming. Furthermore, digital courses for problem based self directed learning were made using Microsoft FrontPage complemented by self constructed tools. Course material has been reconstructed into Re-usable Content Objects (RCO) and stored in a database. A tool was developed to simplify the metadata entry process and based on this tool, RCOs have been described in a database.

8.1 Case 1: File System

8.1.1 Digital Lectures Remote Sensing

The course Remote Sensing Basics (see figure 2) offers an introduction to the comprehensive field of Remote Sensing. It is directed at providing a basic knowledge of Remote Sensing concepts and methods and of the possibilities and limitations of Remote Sensing from aeroplanes and satellites as a source of information for the inventory, monitoring and policy making (Clevers and Vonder, 1999).

The original lectures that were used were presented from a combination of overheads (portrait) and slides. The overheads were partially made in WORD, with pictures glued to the printed versions. A large part of the time was spent on scanning, vectorizing, typing and rearranging the overhead layout into a landscape PowerPoint presentation. Just presenting scanned overheads was not acceptable. It would distract the attention of the student if he had to scroll through each page during the presentation of the audio file. Also, presenting scanned overhead sheets would introduce large file transfer through the Internet, which would undermine the combination of audio and visual presentation at the same time. So using a combination of Real Audio and HTML, 9 hours of traditional lectures were converted into a distance course. 500 slides and 9 hours of audio tape were translated into Internet presentations (RS-Basics Digital Lectures, 2000). Real Audio is a method to compress audio files for real time streaming on the Internet. Studio

recording was chosen over real-time recording because of class interaction, background noises, and changes in sound volume because of movement of the lecturer. So, all lectures were recorded without students, based on PowerPoint presentations (Vonder and Clevers, 1999). Presently the Centre for Geo-Information is experimenting with Synchronised Multimedia Integration Language (SMIL). The World Wide Web Consortium (W3C) has designed this easy-to-learn HTML-like language called SMIL, to enable simple authoring of TV-like multimedia presentations such as training courses on the Web. A SMIL presentation can be composed of streaming audio, streaming video, images, text or any other media type (SMIL, 2000).

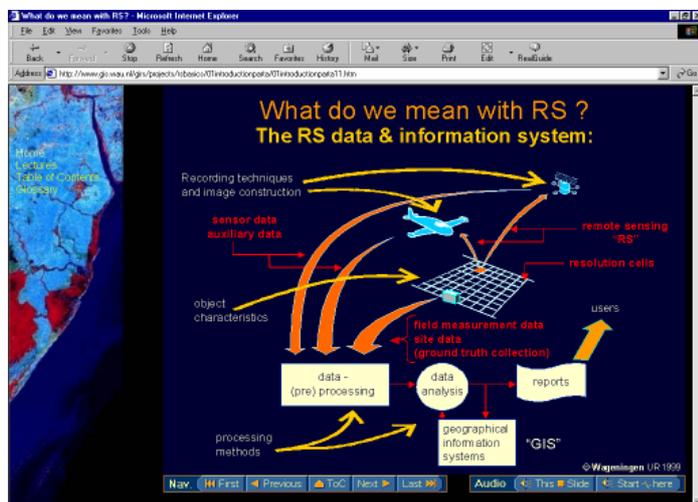


Figure 2: Graphical user interface of the Remote Sensing Basics digital lectures.

Tools: Traditional slides were scanned and redrawn using a combination of PowerPoint 97 and CorelDraw 8. The lectures were taped and converted to compressed digital files using the RealEncoder toolkit (3.0). A tool (Digital Lectures) was developed to convert an exported PowerPoint presentation and a RealMedia file into a digital lecture.

Content reusability: The digital lectures are built from pictures and audio fragments, which can be considered RCOs. HTML is used to combine both objects into one slide (composite RCO). A complete lecture is made of 20 to 30 slides in a row (also a composite RCO). In theory each (composite) RCO can be reused if it has been described with metadata. However, experience learned that it is time consuming to describe each picture and audio fragment of a lecture with metadata.

Evaluation: Evaluation of some tests using either scanned (A4-portrait) sheets or a redrawn landscape version in PowerPoint (PPT) presentations resulted into a clear preference for the latter. So all drawings were vectorized based on scanned overheads using CorelDraw 8 and then imported in PowerPoint. Converting traditional lectures into a digital lecture was possible. However, streaming 30 minutes of audio without any interaction by the student will not keep their attention. It is a nice way for the students to follow a lecture they have missed, or to look up subjects they didn't understand clearly during the live lectures, when studying for the exams. However, to make it a stand-alone distance course, it requires interaction with the student by implementing small exercises and tests after 2 or 3 slides.

8.2 Case 2: File System – Database

8.2.1 The Course Spatial Modelling and Visualisation

The course Spatial Modelling and Visualisation (see figure 3) aims at the learning of the implementation of spatial-temporal simulations by spatial modelling and visualisation techniques. The course has been developed within a MSC setting in which the students work on location or nearby locations (the same network facilities are guaranteed).

The students play three different roles: a 'cohort' student (learning by following lectures and doing practicals), a 'problem oriented' student (learning by defining problems and ways to solve the problem) and a consultant role (group work in a project setting). For each role the learning environment offers RCOs which can be found by a 'blue book' (cohort material), a 'yellow book' (problem oriented material) and a 'green book' (the consultancy material). In comparison with the schedule to work on the problem oriented and the consultancy material the schedule for the 'cohort material' is very tight.

Tools: The course is developed with MS FrontPage 98 and an extension of JOUST. All RCOs have been constructed with well-known software like the different MS Office pro 1997 modules, FrontPage, Corel suite and freeware like

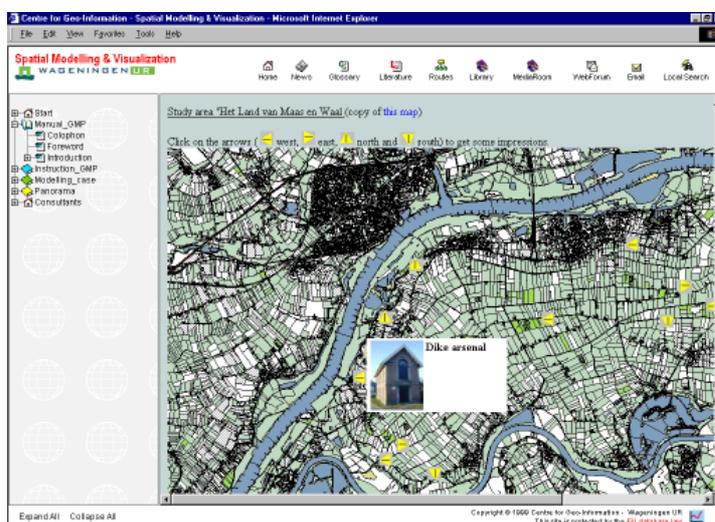


Figure 3: Graphical user interface of the course spatial modelling and visualisation

Xnview and Arachnapholia. Students make use of standard viewers extended with VRML- and Real viewers.

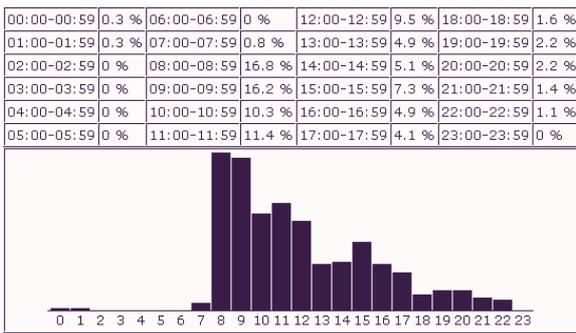


Figure 4: Pageviews per hour

Content reusability: The set up of this course means that the availability of presented materials in the problem oriented approach should be shortly after the presentation. Our experiences learn that within the browsing structure presentations in word, PowerPoint or html could be easily linked and immediately used by students. Data sets provided to work out the project setting are downloaded by all students. However, the average use of the course material is high (during 5 weeks 46 daily users of which 31 are really involved in the course), working online outside the university network turns out to be less comfortable due to the long screen refreshes and downloading times (see figure 4). Experiences with the content reusability by students have not been evaluated yet.

8.2.2 The Food and Bio-Technology Approach

In food and biotechnology (FBT) the type of learning activities of students are not always such that they can easily be implemented as RCOs in a system like the KELLER system (see hereafter). In the FBT courses the student assumes a role (such as junior consultant in a bioprocess engineering consultancy firm, or stand-in supervisor in a students' laboratory) and has to perform in this role in a virtual web based environment (see figure 5). For instance, the real student in the role of supervisor enters the virtual recombinant DNA laboratory. Five virtual students are stuck in the laboratory with their experiments. The real student in the role as supervisor has to detect what mistakes the virtual students have made in their experimental set up and in their analysis. Also there is a library wherein the student can find background information needed to "solve" the case.

Tools: Currently the main tool is MS FrontPage 2000™ and an extension of JOUST. In the libraries we use JavaScript, Java, and some animations. For authentication and user profiles we use an MS Access database and Active Server Pages (ASP) or PHP

Content reusability: The libraries could just as well have been built in any learning environment. However, the difficulty is how to fit the interactive cases in such a learning environment. For this reason and because at the time of development the market for learning environments was extremely turbulent (with several important players pulling back their respective learning environments) we chose to develop the libraries in MS FrontPage as well. In general most content in the library can be considered re-usable but content in the cases is currently not re-usable. For learning environments this clearly poses a research question.

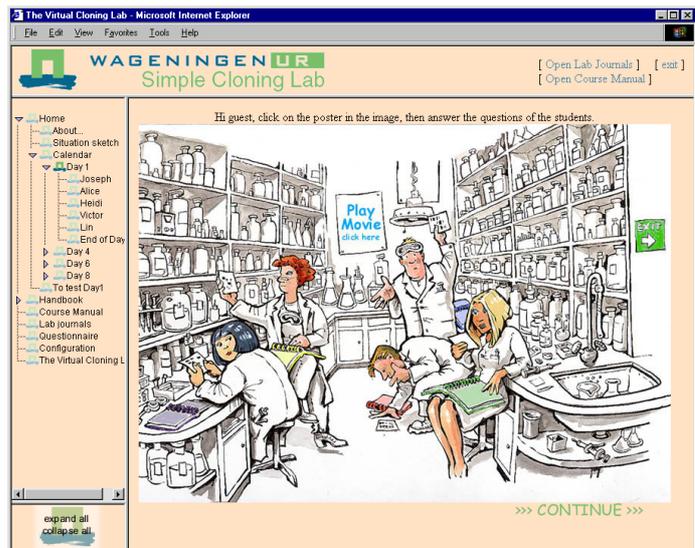


Figure 5: Graphical user interface of a food and biotechnology course

8.3 Case 3: Database

8.3.1 KELLER

In certain courses we use relatively much audio-visual material. In particular for these courses we build (together with the company Interactive Network Services) the KELLER system. Over the years there have been produced 18 courses over the web with this KELLER system. The KELLER system is named after John Keller in honour of his work on motivation. We advocate the use of John Keller's ARCS (Keller, 1987) model by the authors of RCOs. However, the architecture and functionality of the KELLER system does not force the authors to follow John Keller's ARCS model.

The KELLER system is a fairly complete learning environment, which is particularly suitable for courses with relatively much non-text based re-usable content objects. A student doing one of these courses typically views an audio-visual presentation which introduces a new concept, makes an assignment which is typically of the type "design" or "puzzle" and views - if needed - some audio-visual hints or an explanation of a standard answer.

Tools: The KELLER system itself was built using Cold Fusion™ and JavaScript and MS SQL Server™. The re-usable content objects are very often movies such as audio-visual Lotus ScreenCam™ movies or AVI movies (produced with

Hypercam™). But about 30 percent of the content has been authored with Authorware Professional™ and also MathCAD Worksheets and AutoCAD models are typical RCO types.

Content Reusability: The KELLER system allows authors to upload content objects into the system using network neighbourhood and to add and edit metadata from within the system. Authors use these metadata later on to reuse content and for course configuration and students use the metadata to retrieve those objects they need in a specific situation. The KELLER system supports four of the five standard search functions (Hierarchical search, browsing, keyword search (manual indexing), and following referential links. Most KELLER courses are concluded with an "open book exam" where students can use the whole database of objects during the exam.

9 RESULTS AND CONCLUSIONS

Assessment: The KELLER system was developed for use in courses within the domain of Computer Science and Applied Information Science, Agricultural Technology and Geophysics. Students were positive but it was found important to substantially reduce the costs of entering metadata for re-usable course content. Furthermore, this system requires user administration at two levels: the operating system and that of the KELLER system itself. Finally, the KELLER system does not handle compound RCOs.

Platform survey: It was found important to be able to reuse course content. Therefore, it should be stored in small recognisable parts at a central place. This requires that they be described by metadata in order to enable lecturers to search for components when building a new course.

Course structure: It was found that a traditional chapter structure gives the student the best overview of the learning route (KELLER system). However, within one course there can be multiple learning routes. MS FrontPage supports automatic maintenance of the hyperlinks for the chapter – section structure, the other sets of hyperlinks must be maintained mainly manually. Maintenance of multiple learning routes can easily become expensive. Systems like Hyperwave could well provide the solution.

Environment: The course environment should be uniform for all courses. High click frequencies should be avoided. Students should be able to navigate from content to content or from content to learning route with as few mouse clicks as possible. Therefore "fast buttons" should lead to similar information in all courses. The "fast buttons" should always be available on the desktop and so should the learning route.

Student–Teacher interaction: We believe that student–student interaction and student–teacher interaction should both be well supported. Many systems are available mostly denominated as Computer Supported Collaborative Learning systems. Integration with systems based on a digital library paradigm (like in GENTLE) is seldom realised. Experience in the past has shown that computer controlled interaction is prohibitively expensive.

Demo: As part of our search for the most satisfying learning environment we have build a Digital Learning Environment Demo, using Microsoft FrontPage 98/2000 in combination with self developed tools or freeware. In that way we were able to improve and articulate the set of functional requirements with respect to the digital learning environment that fits best our situation. Important aspects are course structure, navigation, data structure re-usability and meta information. Content reusability was realised by storing the content of various courses on a web server. All objects were documented with metadata. A metadata search engine makes it possible to search through the meta information, and a content search engine enables free text search in all HTML, Word, Excel and PowerPoint files. These search engines can be made available in or outside a course. In such a way students can collect additional information to the course content and teachers can search the digital library when making a new course. An Internet Browser was found the best medium to present digital courses. Browsers are mostly free and usually installed on every PC nowadays. Although each course can be made location independent in such a way, one should be aware of the fact that students often cannot afford to buy software licences for expensive GIS/Image processing programs. Therefore each course should contain a list with programs needed to follow the course. Certain courses will only be suitable for the university Intranet.

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