Handling material in learning activities. The Knowledge Infrastructure KOIN

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Abstract.
This paper focuses on the software support for handling materials during learning activities. Learners must be provided a rich learning environment offering not only material, but also an opportunity to discuss this material and relate the material to own experiences and actions. Materials must also be transferable between different courses, and students want to store them themselves for further reference. As these requirements are contradictory, they are difficult to meet with a single solution. This paper presents an integrated approach, relying on the combination of different support technologies in order to meet these requirements. A platform for handling material in a cooperative learning activity, the Knowledge Infrastructure KOIN, is presented as key part of this integrated solution.

1 Introduction
Learning activities depend on working with materials. In any instructional or learning situation, some kind of material – a book, a lecture, some papers, increasingly in digital form – is used by the students. The material is then worked with, it is read, listened to, discussed and commented. Many didactic methods include some form of own production of material, such as a report, a presentation or the production of some digital objects as practical exercise. Even within the strict instructional setting of a lecture with oral exam the students work with materials. This may be their own notes made during the lecture, which they later reorganize and condense as a preparation for the exam.
This paper focuses on the software support for working with materials in different kinds of educational settings within the university. While virtually any support for learning activities supports the handling of materials, we argue that the support provided by common tools is not sufficient. We claim that common learning platforms fall short in supporting two important aspects of the work with materials: the reorganization of material during the learning process and its storage for later reference by the students. We present an integrated approach which uses different kinds of media to handle and organize material for learning activities. The key part of this approach is a cooperative learning platform, which supports cooperative re-organization of the material as well as the generation of individual reports for later reference.

This paper is organized as follows. We start with the description of the role of materials in different university learning situations and formulate requirements for the handling of materials in the third part. Against this background, advantages and drawbacks of common software support for cooperative learning are discussed in the forth section. In the fifth section, we describe our own approach of an integrated framework for material handling.

2 Use of Materials in Learning Activities

2.1 Lecture

Lecturing includes one important form of material: The presentation material shown to the students. With the wide-spread availability of screen projection technologies like beamers these materials can be – and increasingly have to be – digital. Replacing various kinds of other media, like blackboards, overhead projection or slide shows, this presentation software needs to accommodate a variety of media as well as lecturing styles. Accordingly, software for presentation is needed. In most courses, the presented materials are handed to the students as hard-copies. Students use these as reference when preparing exams, annotating them on paper and usually composing hand-written notes. Some lectures are accompanied by exercises. These exercises, usually handed to the students on a weekly or bi-weekly basis as well as the solutions worked out by the students are materials as well. Depending on the quality and practical nature of the lecture, the materials as well as the compilation of the students may be used by them for later reference during work practice.

2.2 Seminars

Seminars usually include an introductionary part prepared by the instructors and a part in which students present their theses. Material for a seminar includes presentation material for the introduction as well as for each student. The prepared theses are based on a variety of material, mostly literature. The theses themselves are material, too. In preparation of their thesis, they scan and organize the material, relate it and finally compose their thesis based on the materials.

2.3 Practicum

In a practicum (practical course) three main types of materials are used: The materials of the previously studied theory, and – depending on the type of practical application – work material and the results of the work. As an example, we describe one practicum in detail: In the practicum “Multimedia and Interactive Systems students gather their first experience in designing and realizing an interactive, multimedia system. While the
Handling material in learning activities. The Knowledge Infrastructure KOIN

The concept - design and storyboarding – the students are as well required to turn in a complete and running result of their work together with the concept. The practical is divided in two parts. In the first part, students are introduced into different means for the production of digital media, such as 3D production, Animation, CD-Rom production, video mastering, audio tools etc. During the second part, the students design and develop an interactive digital system in small project groups of 2 to 4 students.

During the practical, the students have to work with and handle different kind of materials: For the first part, teachers provide self-studying material (tutorials etc.) and may give presentations introducing the tools. They also may provide material for practical work during the introduction, e.g. video material for cutting or raw audio files, pictures etc. The students usually produce some sort of output, like a small Flash film, a video sequence etc.

During the design phase, the students have to work with raw material. Depending on the project, they have to gather or produce these materials themselves (take photo, shoot videos, record audio), and provide them to the rest of the project group. For the concept, they need to discuss a design and a storyboard and which is presented to and discussed with their fellow students. After the concepts are consolidated, they start creating their digital products. These digital products are sometimes used as starting points for further projects and the students like to show them in application for jobs. While this practical might be sort of an special example since the learning process is also a production process involving a wide range of digital working material and output, settings like this are not unusual in teaching digital media.

In the practical, the students usually meet once a week at university to discuss their work with the supervisors. Sometimes they meet a second time during the week to work on their projects, but they might as well divide up the work individually or computer-mediated collaborative during the rest of the week, or they may meet at some student’s home to work on the project.

2.4 The use of materials in learning situations

The described university learning activities include the use of a great number and wide variety of materials. These materials become more and more digital. Although the described courses where quite different, the used materials can be classified into three categories:

1. Presentation Material. Presentation Material is used mainly during the lecture, but as well for introductory parts and student’s presentations in the seminar and in the practicum.
2. Reports. Reports are the “outputs” of the learning process, ranging from a thesis written for the seminar to short compilations made in preparation of an exam.
3. Raw Material. As raw material we denote all other kinds of materials, like literature or the materials for the practicum’s production process.

Materials may come in all kinds of digital format, from plain Text to HTML-Pages to digital video clips. Some of the materials need to be referenced some time after completion of the course. This leads to a set of requirements for handling digital material in cooperative learning activities, which will be presented in the following section.

3 Requirements for Digital Archives

During the last years working with different kinds of digital archives, we have collected requirements we found for these archives. These requirements are presented in this section, illustrated by the three learning situations introduced in the previous section. According to the described situations, we differentiate between different activities, like
providing material for presentation, working with materials and later reference. There are, though, some general requirements important for all these activities:

### 3.1 General requirements

*Storage for all kinds of materials.* During the learning activity all kinds of raw material may be useful to include, and therefore the archive should be able to store them. This is true in settings like the practicum, where working material is included in the process, but as well for any other kind of learning activity, since the formats of digital material may not be foreseen.

*Easy access and easy editing of the materials.* Since as well teachers as students often work from home or during travel or from different sites on campus, the access to the archive has to be realized in a way open to the a variety of use situations. It should also be possible from these sites to edit or add new material.

*Access Rights.* The archive should provide means to attach differentiated access rights to the material. E.g. students should not be able to alter lecture presentation material, and students may want to hide preliminary results from professors or fellow students.

### 3.2 Requirements for presentation material

*Easy Production.* Since professors usually have a heavy workload, and students should concentrate on the contents rather than format, the production of presentation material should not impose extra work on them. It should also be possible to produce material without server or internet access, for instance during travel or at home.

*Reuse and versioning of presentation material.* Since professors usually repeatedly teach the same subjects, the presentation material should be reusable. If used in different years, it also needs to be versioned.

*Presentations without special software or downloads.* Since lectures may be held in a variety of locations, it should be possible to present the material without the need to install special software on the presentation computer.

*Presentation with and without server or network access.* Since internet access is not guaranteed on all sites, it is also necessary to be able to present the material from a CD-ROM or local hard disk as well as from a server.

### 3.3 Requirements for student’s work with the material

*Addition of new material by students.* For all kinds of cooperative learning activities, Students should be able to add their own material to the archive.

*Organization of material.* If students are to work with the material, a sequence of first collecting a wide variety of material, from which relevant material will be selected later, is typical. Therefore, material needs to be categorized and organized after it has been added to the archive.

*Integration with the cooperation facilities* - *Annotation, discussion, and rating of the material.* Students need to be able to annotate, discuss and maybe rate the collected raw material as well as presentation material.

### 3.4 Requirements for later reuse

*Students should be able to access the material in the archive years later to prepare exams and during work practice.* While it seems to be easy to maintain the archive in ser-
Handling material in learning activities. The Knowledge Infrastructure KOIN

vice over years, there are several, mostly organizational problems to this approach: Students may take longer for their studies than provisioned, they may change the university and even the country to continue their studies, and they may even travel to and work in circumstances where they have no internet access and not even a computer. While some may find it more convenient to store the material on an internet server where they can access it from any connected computers, others may need to print out relevant parts of the material for later reference or save it to local files. In this point, archives for learning differ from knowledge management, as the main objective of universities is that individuals gain individual knowledge. They should therefore be able to take the results and materials of their work with them as far as possible.

Conclusion. The stated requirements are quite contradictory, since annotation, discussion and reorganization are best realized with centralized, server-based solutions, while independent presentation and reuse by students are only realizable with server-independent solutions based on common file formats.

4 Common Solutions

For the spectrum of requirements described above, three main families of platforms are available: Web portals/Content Management Systems, Groupware Systems and Learning Platforms.

Web Portals and Content Management Systems (CMS). Web based presentation of content – supported by an underlying document/content management system – may offer viable support for the production and presentation of presentation material by teachers. Therefore, they support the first two sets of requirements (general requirements and requirements for presentation material). Content Management Systems do not, though, support the student’s work with materials, as most CMS only allow for a limited set of authors, and therefore do not support the addition of material by students. Also, they do not provide cooperative facilities, like annotation and discussion. As many CMS provide HTML-Export facilities, they do support the later reuse of material.

Groupware and Community Solutions. Groupware Solutions like BSCW (Klöckner 2000), CommSy (Pape et al. 2002) provide good support for cooperative functions and the exchange of material and therefore meet the general requirements as well as the requirements for students working with the material. Groupware solutions fall short in the support for the provision of presentation material and later reuse. As cooperation tools, they do provide support for student’s work with materials, as they support exchange, discussion and usually annotation of materials. Their means for permanently storing results of the work are limited. Keeping the learning platform open in order to make the material accessible after completion of the course is impractical out of two main reasons: The material collected in the Cooperation Space is usually much more than needs and should be kept for later reference. This imposes unnecessary storage costs on the host as well as difficulties to retrieve the relevant materials by the members some time after the work was finished. In short, the strength of learning platforms lies clearly in coordination, discussion and annotation facilities. They usually do neither support the production and use of presentation material nor the export and reuse of resulting material (reports).

Learning Platforms. Learning Platforms like LearningSpace¹, Blackboard² and WebCT³ provide a combination of authoring environment, delivery function and annotation/groupware facilities. Most of them do not support the management and exchange of

¹ LearningSpace: http://www.lotus.com/products/learnspace.nsf/wdocs/homepage
² Blackboard: http://www.blackboard.com
³ WebCT: http://www.webct.com/
arbitrary files, and thus fail to meet the general requirements. As their main focus lies in the provision of self-learning units for distributed learning, they might be used for the authoring and distribution of presentation material, but will not support it optimally. Student’s work with the material is also only partially supported. Most Learning Platforms provide asynchronous discussion tools and annotation facilities. They do not, however, support adding and exchanging of materials by students. As many Learning Platforms provide some kind of export, material can be stored and reused by the students. Again, this support is partial, as the export functions usually only support export of the study-material provided by teachers.

Finally, all of the mentioned approaches have to be questioned in terms of durability. Whilst a company may decide for themselves how long to support a special system (e.g. for knowledge management), in a university setting the situation is different, since student should be able to “take their knowledge with them”, and access it from outside the organization. Durability of technology is another issue: While it often is taken as a matter of course that the web and the internet will be there for quite a while, this cannot be taken for granted. This is especially true for research prototypes and commercial solutions which may be discontinued and commercial solutions as well.

The solution we found is an integrated approach, aiming at combining different solutions to maximize the advantages and minimize the described drawbacks.

5 Our Approach: Integrated Archives

As described in the previous section, common solutions to learning archives all have their drawbacks. We propose a composed solution, integrating several technologies in order to obtain archives for teaching and learning supporting all requirements for handling learning materials. The described solution is used to support whole range of courses in Media Informatics offered at the University of Lübeck.

The approach consists of four parts: a format for presentation material, called Micromodules, a portal, a web based cooperative hypermedia system including several archive functions, called the Knowledge Infrastructure KOIN and finally reports exported from the KOIN.

5.1 Presentation Material format: Micromodules

We defined a presentation format we call “Micromodules”. Micromodules are HTML-based presentations of topical units optimized for presentation in class. (see Figure 1) A lecture is build out of several Micromodules. Micromodules may be exchanged between different lectures as well as between different teachers. We chose the HTML-Presentation instead of using any kind of platform or XML-based solution out of the following reasons: As they are plain HTML-Files, they can be edited with any HTML-Editor and therefore can be authored from arbitrary locations. No server connection or sophisticated XML-publishing framework is needed to visualize the modules. By choosing the HTML format, we avoided tying our content to any special platform, as common e-learning platforms as well as content management solutions depend on their own formats (Weitl et al, 2002).

As websites, they also allow for easy referencing of single pages as well as reuse and organization of Micromodules into a lecture structure, which cannot be realized as easily with common presentation formats, like for instance PowerPoint. By using Dreamweaver templates to create the modules, we gained the opportunity to export them as

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Handling material in learning activities. The Knowledge Infrastructure KOIN

XML-Files based on the template structure, making it possible to reuse them in a XML-based infrastructure which are increasingly developed (see, among others, Lucke and Tavangarian, 2002). Thus, Micromodules provide several advantages commonly associated with server-based solutions.

5.2 The Portal “Media Informatics”

The Portal “Media Informatics” is an information portal offering unified access for all students and professors for material important for all courses offered in “Medieninformatik”. Professors access their Micromodules via the portal. They have access to all Micromodules, enabling them to easily include material prepared for other occasions as well. Depending on their didactic concept, they use the portal to provide these materials to the students before, directly after class or at the end of the terms. The Material is usually, due to student’s wishes, sequentialized and prepared for easy printing.

Besides the access to the Micromodules for students and professors, the Portal holds general information on the curricula, about all courses as well as additional material for self-study and an experimental room where students can add their own material.

The portal is accompanied by a discussion forum open for all students.

5.3 The Knowledge Infrastructure KOIN

The Knowledge Infrastructure KOIN is based on a web based cooperative hypermedia system called “Cooperation Infrastructure (CI)”. As such, it offers usual cooperative tools to the students, like bulletin boards, chat, or awareness support. The Knowledge Infrastructure extends the CI by three material archiving functions: the File-O-Rama allowing to store arbitrary material, the annotation facility to include external material and the report functionality allowing to export material for later reuse.

5.3.1 The File-O-Rama

The File-O-Rama allows for arbitrary files to be stored on the KOIN server. The files are organized in a virtual file system, visualized by a tree view in the left part of the screen (see Figure 2). The File-O-Rama is a place where students can collect and organize all kinds of working materials, including “exotic formats” and very large files, as needed for video clips. They can organize the material by the hierarchical structure of
the virtual file system. The File-O-Rama attaches a hypermedia node to each file, providing space for all kinds of additional information. As this additional file information are hypermedia nodes, they can be linked into the hypermedia networked of the CI and therefore be easily referenced in discussions and all other material collected within the CI. The File-O-Rama supports the exchange of raw material like pictures, videos and sounds, as well as the storage and exchange of material provided by teachers or students not fitting in the presentation format.

5.3.2 Annotation Facility

The KOIN’s annotation facility allows for the annotation of arbitrary web sites. If these sites are viewed via the KOIN as annotation proxy, small icons indicating existing annotations are included on each site. The annotations are linked to the relative site name of the pages and are thus robust in terms of changes to the page as well as relocation of the whole Micromodules. Annotations are, again, nodes in the hypermedia network of the Cooperation Infrastructure and can thus be integrated into discussions and all other objects within the CI. Annotations are therefore not only a tool to attach annotations to websites and especially the Micromodules, but also a way to include external material into the hypermedia network.

5.3.3 Preparing and Exporting Reports

Besides integrating pre-existing material with annotations and accommodating all kinds of material in the File-O-Rama, the KOIN can be used to produce condensed reports. Reports are basically hierarchically structured subsets of the hypermedia network. They may include inclusions of and links to other hypermedia nodes, such as annotations, file meta-information or messages in the discussion board. The reports are created creating and editing hypermedia nodes within the KOIN. The hierarchical structure can be visualized using the same tree view as for the File-O-Rama and can be reorganized by editing the nodes or in other interactive tools, like a MindMap view (see Figure 3). Reports can be short papers in which the students summarize the course for themselves, presentations in the Micromodules-format, as well as seminar papers and are described in detail below.
The preparation of reports is supported since it allows students to reorganize the collected material and token notes and incrementally build an excerpt structure. Reports created within the KOIN are exported as XML, HTML and PDF-Files for later reference. As such, they can be easily stored by the students and archives privately for later reference, be altered with commonly accessible tools (and even integrated into other servers and search facilities). They can be printed as PDF-Files in an easily readable way. As HTML-Documents, they keep some of their hypertext-functionalities as links between parts of the reports as well as to Micromodules can be preserved and easily followed using any Browser for viewing. Since they are composed by the students themselves, they hopefully only consist of sorted material which can and will be reused by the students. The report preparation process itself is part of the learning process. Reports can be integrated into the portal to further disseminate them between students in different courses.

![Figure 1: Report Organization using the MindMap tool](image)

### 5.4 Integration

Portal, Micromodules and KOIN are integrated in the following way: The portal provides a unified access to all three components. Via the portal, students can access annually sorted archives of Micromodules for all taught courses. For actual courses, links to the KOIN are provided. KOIN and Micromodules are integrated via the annotation and report facility. Annotations provide two-headed links between Micromodules and hypermedia objects within the KOIN. Micromodules may be produced within the KOIN using the report facility.

### 5.5 How the integrated solution meets the requirements for material handling

#### 5.5.1 General requirements

*Storage for all kinds of materials.* Within the KOIN File-O-Rama, arbitrary files may be stored.

*Easy access and easy editing of the materials.* Micromodules can be edited with any text- or HTML-Editor. Files within the File-O-Rama can be accessed from any Computer with an internet connection and web browser.
Access Rights. KOIN provides access rights based on hierarchical user groups.

5.5.2 Requirements for (the provision of) presentation material

Easy Production. Micromodules can be edited with comfortable HTML-Editors. As they are independent HTML-Files, they can be edited offline.

Reuse and versioning of presentation material. Micromodules are archived within the portal with different versions for each course they were used in.

Presentations without special software or downloads. Micromodules can be presented using any actual Browser.

Presentation with and without server or network access. Micromodules can be copied to local hard-disk or CD-Roms.

Flexible support of different presentation styles. Within the restrictions of Websites, the Micromodules can be navigated freely, supporting individual presentation styles.

5.5.3 Requirements for student’s work with the material

Addition of new material by students. Students can add any kind of material in the File-O-Rama.

Organization of material. Material can be organized both using the structure of the virtual file-system or by linking into the hypermedia structure. KOIN offers additional support for hierarchical structuring of hypermedia nodes, which can be used to structure, for example, reports (see Figure 3).

Integration with the cooperation facilities - Annotation, discussion, and rating of the material. Based on a cooperative hypermedia system, KOIN provides both cooperation facilities and an annotation facility, which can be linked into the hypermedia structure.

5.5.4 Requirements for later reuse/Students should be able to access the material in the archive years later to prepare exams and during work practice.

Reuse is supported by the report facility. As reports are condensations of the material in the KOIN created by the students themselves, they should contain the right amount of information. As HTML-Files they preserve links to the Micromodules and are printable.

6 Conclusion and Further Work

This paper pointed out the importance of material in the course of university learning activities.

In our work, we found that no single solution – using a groupware product, a web system like CMS or portals, etc – will fully suite the needs for handling and archiving materials of the learning processes at universities. We therefore evolutionary developed an integrated solution including a format for presentation materials, called “Micromodules”, a web portal and a cooperative hypermedia system (Knowledge Infrastructure KOIN) supporting collaboration, annotation and the export of generated reports. Exported Micromodules and reports guarantee the accessibility of results by students after years, even if KOIN and the server are no longer maintained.

We have used and evolutionary developed the described approach during several semesters now. Experiences with Micromodules show that they are quite useful for presenting the material during lectures, and significantly reduce work in the long term as they are highly reusable and exchangeable between lectures. There is still room for improvement in terms of easy authoring as well as optimal support for presentation. We found a design contradiction lying between supporting a smooth flow of presentation with a prede-
fined order in contradiction to the ability to dynamically choose the next presentation “slide” in the Micromodules.

Further work will include the creation of an programming interface to enable students to adapt the generated reports to suite special needs and generate arbitrary output formats.

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