



# SCHOLION - Scaleable Technologies for Telelearning

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## ABSTRACT

SCHOLION is a novel type of educational environment. It has been designed and developed to overcome current limitations of distributed hypermedia environments for continuous user-centered teaching and active learning support. It provides individual facilities for knowledge producers and consumers, as well as a common information space for focused interaction. The fundamental idea in design has been the emphasis of individual and global link management to implement both, the individual and global context-sensitive communication among knowledge providers and consumers. In addition, the structuring of knowledge to be transferred from producers to active consumers has been strongly coupled with the idea of individual navigation and annotation of pieces of knowledge.

## 1. INTRODUCTION

Since in an information society learning should be enabled for everybody, everywhere, and anytime, technologies for distance and distributed learning are promising candidates for a proper support [11] [9] [13] [12] [7] [15].

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They are also candidates to increase interactivity and collaboration between knowledge providers and consumers. Corresponding features are likely to replace the old-fashioned one-way, passive knowledge transfer, and finally reduce the organizational overhead related to the concepts of open universities [5] [6] [10].

As a consequence, distributed, but individualized learning environments have to be developed that enable the bi-directional communication among knowledge providers and/or knowledge consumers based on common materials and context sharing.

In this paper we deal with the development of such an environment, namely SCHOOLION. The target user groups of the SCHOLION environment are knowledge consumers, as well as trainers, lecturers and knowledge providers from (business) schools and universities (we will term them knowledge producers). Benefits are to be expected for both user groups: (i) Knowledge consumers are enabled to leave their passive role and become an integral part of the knowledge transfer process. This immersion of learners into the transfer process is achieved through telecommunication facilities, individual knowledge navigation, and annotation. (ii) Knowledge producers can actively seek for feedback from their recipients of knowledge in a context-sensitive way.

In the following section we will review related work. In the section SCHOLION the requirements for individualized and context-sensitive producer  $\leftrightarrow$  consumer communication, as acquired from potential end-users, are detailed. Then, the features of SCHOLION meeting these requirements are introduced and exemplified. The section concludes with a sketch on the architecture of the hypermedia-environment. We finally conclude with a reflection of the objectives and achievements.

## 2. RELATED WORK

Traditional teaching and learning materials are available to knowledge consumers either online or off-line, such as on CD-ROM. Various digital library projects, such as [3] [4]

[8], have shown that electronic publications are generally not preferred by consumers over hard copies, such as paper. In [14] several reasons for this experience are detailed, among them the possibility of making arbitrary complex textual and graphical annotations. Hence, the possibility to annotate information graphically seems to be an essential feature towards end-user acceptance of electronic media for learning. In the following we will review the state of the art describing some of the recent achievements.

**The Teleteaching project Mannheim-Heidelberg** [15] has the goal of developing a prototype of a semi-virtual university. The software enables (i) the preparation, distribution and provision of teaching and learning material, (ii) an integration of user interfaces of telecommunication software (video, audio), (iii) recording lectures, seminars etc., and (iv) synchronous on-line learning at the knowledge consumer's home. Since the project focuses on the availability and dissemination of electronic course material, no features have yet been developed to support widely customization of knowledge and individual navigation.

**„Teleteaching Dresden-Freiberg“** [15] has the overall goal to support multimedia-based lectures, in order to (i) encourage knowledge consumers using on-line interactions, (ii) provide on-line course material, (iii) enable asynchronous interaction during lectures. Again, the provision of electronic course material has been emphasized, and individual access facilities have still to be developed.

In [1] several projects for AOF (*Authoring On the Fly*) are mentioned, targeting towards developing software to provide lecturers (authors) with special tools to create hypermedia teaching and learning materials „on the fly“. They focus on merging activities like online teaching in class, teleteaching and courseware production into an integrated feature becoming available in an open platform. However, AOF also focuses on developing and delivering course materials, and does not address annotations at various levels of granularity.

**RTB-Berlin (Berlin Regional Testbed for „Hypermedia-Teaching-Units for Student Training“)** [15] is intended to establish multimedia services for lecturers based on facilities for creating hypermedia teaching and learning material. The course material should become available to the knowledge consumers via telecommunication channels. Since the project so far focuses on the development and dissemination of course material, it does not consider the development of features for individual annotation and navigation.

**I-CARE (Cyberspace Assisted Responsive Education)** developed at **PRIDE (Polytechnic Research Institute for Development & Enterprise)** [15] targets towards courses responsive to knowledge consumer's learning needs by exploiting the Internet as a medium for communication as well as a tool providing source. I-CARE provides: (i) *communication tools*, such as e-mail, telnet, ftp and chat session; (ii) *groupware tools*, like group calendar, bulletin board, appointment books and discussion forum; (iii) *information tools*, such as search engines, on-line databases and dictionary and (iv) *Internet resources*, like reference documents, FAQ-files and links. However, I-CARE does not enable the customization of course material, too.

**IRI (Interactive Remote Instruction) System** developed at the **Old Domino University** [15] has the objective to develop a virtual classroom using interactive remote instruction by taking advantage of the continuing cost reductions in video electronics, computing and communication technologies. The IRI system melts high speed networking, television, and computer technologies to allow distance education in a virtual classroom over the Internet. Knowledge consumers share learning experiences, independent of their physical location. The problem providing annotation features for knowledge consumers has not been tackled so far.

**WebCT** has been developed at the **University of British Columbia** [15]. It facilitates the creation of sophisticated World Wide Web-based educational environments. It allows educators to design the layout and presentation of course pages and provides a set of educational tools that can be incorporated into any course. In addition a set of administrative tools assists educators in the task of course administration. Beyond that, as a part of communication support, WebCT provides the possibility of personal annotations referring to entire web pages. It therefore meets the principal requirement for individual annotation, however, lacking several levels of granularity.

**HyperCourseware** has been developed at the **University of Maryland** [15] with the objective to support the preparation and presentation of materials, as well as the dynamics of education in an electronic teaching environment. It consists of a Home Screen and a set of interconnected modules organized as follows: (i) *Course Materials* - providing general information about the courses such as syllabi, contents, readings, assignments and class members; (ii) *Course Products* - providing specific information about a particular course like schedules, written notes, projects, exams and grades; (iii) *Course Tools* - providing tools or facilities, such as the course setup, a directions and a seating module, mail, chat- and discussion facilities. Although written notes enable annotation as a part of the course products, annotations are not enabled at various levels. The tool merely allows page-wise annotation.

As we can see, most of the existing educational environments do not provide features for individual annotations. From the systems reviewed WebCT and HyperCourseware are the only products that enable content annotation, and thus, allow knowledge consumers to annotate a web-site. However, the targets of annotation are entire web-sites, rather than individually interesting paragraphs, sentences or single items within a site or document. Nevertheless, in [2] the demand for individual annotation facilities has been confirmed. Knowledge consumers need not only to be enabled to annotate but also to create associative link structures to produce their own summaries and to draw additional diagrams etc. The study also reveals that annotations at various levels of granularity is one of those fundamental problems that has not been solved by now. Once this problem could be solved, the end-user acceptance of hypermedia course materials and navigation concepts is likely to increase.

### 3. SCHOLION

After validating the end user requirements through additional interviews with University teachers and students, SCHOLION's objectives have been transformed to the following functional groups of features, according to the needs of the target user groups:

- features for content manipulation, namely to graphically markup and extend the course material according to individual needs and preferences,
- features for session control, discussion and feedback, including the structured documentation of discussions, as they occur in the course of understanding and learning.

In detail, **knowledge producers** requested support for creating or editing course material:

1. *Creating a slide:* A new slide is added.
2. *Removing a slide:* Referring to a previously created/selected course material an existing slide is selected and removed/deleted.
3. *Editing a slide:* Referring to a previously created/selected slide, an author is enabled to add/remove various kinds of media including text, pictures, audio-files and video-files. Additionally, permanent links may be defined (which cannot be removed by knowledge consumers), changed or removed/deleted.
4. *Creating a presentation:* Multimedia presentations are created to provide self-guided understanding of the subject at hand. Basis of such a presentation is an existing course material or the referenced slides, respectively. Therefore, highlighted or underlined text, media and triggers might be added to a relevant slide. Triggers have to refer to a certain part of a slide (text, audio- and video files), and specify the sequence (runtime behavior) of a presentation. They activate/start the referenced item (highlighted or underlined text, audio- or video files) at a certain time. The latter is defined when adding the trigger.

**Knowledge consumers** requested support for:

1. *Working with a course material:* The starting activity when working with a course material is to open a certain course material. Once a course material has been opened, the user has the possibility to
  - *play a presentation:* During the presentation the user may stop the presentation at any time, in order to work on the course material (see next item) and to continue/restart at any time later on.
  - *work on a course material:* When working on a course material the knowledge consumer is able to (a) insert additional links (probably referring to a previously selected text), (b) trace existing links, (c) add annotations, (d) highlight or underline selected text, (e) ask questions referring to a certain text or slide, (f) add bookmarks, (g) add private index entries/keywords.
  - *trace keywords referring to the index of the active course material:* Each course material contains an index of keywords, which is initially created by the author.

However, the knowledge consumer has the possibility to add a private index (see above). Using the list of keywords the user may jump to the selected keyword's targets within the course material currently active.

- *jump forward/backward:* These features allow the users to navigate through the course material specific to their history. It can be achieved the same way like browsing HTML pages using common „World Wide Web (WWW)“ browsers.

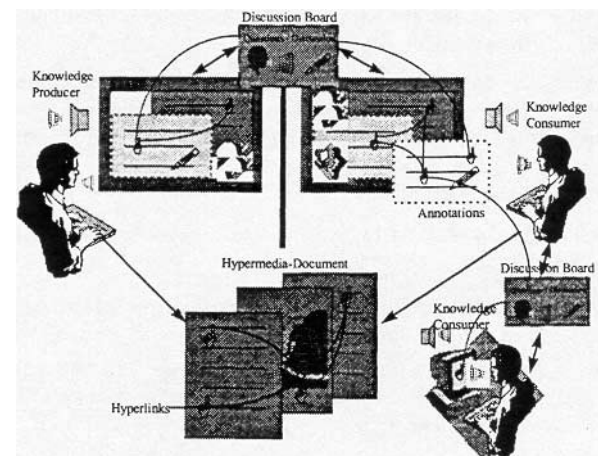
- *browse "course material":* The knowledge consumer has the possibility to work on a course material (i.e. set of slides) in a linear way.

2. *Working with the discussion board:* There are two entry points to the discussion board:

- *Asking a question referring to a certain text of a slide:* In this case, the question occurs when working on a certain slide of a course material. The consumer has either the possibility to create a new discussion or to select an existing one (with a related topic). Then, the question may be added by creating a new comment referring to the selected discussion.

- *Opening the discussion board because of certain interest:* In this case, the user has the possibility either (a) to create a new discussion (topic), or (b) to choose a discussion in order to (c) write a new comment referring to this topic, or (d) to choose a comment in order either (e) to read the content, or (f) to write a reply.

3. *Tracing a bookmark:* The required bookmarks can best be compared with the ones we know from common WWW browsers. The users may refer to a predefined bookmark either to a whole page/slide (if no part of the certain slide has been selected) or to a certain part of a slide. Once a bookmark is set, the user may refer to its target at any time.



**Figure 1: The Concepts of SCHOLION**

Based on the acquired requirements the conceptual design of SCHOLION as shown in figure 1 has been developed.

It is supposed that the applied course material can be provided by several authors (i.e. knowledge providers, trainers, etc.) or by institutions (i.e. schools, universities, companies,

etc.) according to the (object-oriented) model of the hypermedia documents required for SCHOLION. Each hypermedia document - see center of figure 1 - comprises predefined hyperlinks to graphics, animation (for example, programmed in Java), spoken text or videos as mentioned above.

Any SCHOLION course material consists of various slides (similar to HTML pages in the WWW-application), in order to provide an easy to grasp and flexible structure of the course material. As a slide may contain text, link, picture, audio or even video, these elements need interactive references. Therefore, a Slide consists of a so-called Styled-Document storing the text and link elements in a format similar to RTF (Rich Text Format) and media storing picture, audio and video objects in the common compression format supported by Java.

### 3.1. Underlying concepts

The individualization of learning material is enabled through the *profile concept*. Any course material can be enhanced by the user with so called markups: Users might add annotations and links, ask questions or change the layout (highlight, underline) of the course material. All the markups added to the course material by a user are collected in a profile. Since SCHOLION is a client/server application, the course material is stored on the SCHOLION-server and the user profiles are either stored on the SCHOLION-client (defined private) or uploaded to the server (defined public).

Every time a knowledge consumer views a slide of the course material, the slide will be loaded, enhanced with the markups of the user-specific profile that is related to the concerned course material. When the user adds markups, only the profile is being changed, whereas the course material itself has not to be touched. As a further benefit, a user may view several profiles at a time (displayed in different windows), in order to overview the entire set of publicly accessible annotations for a particular course material.

Whenever opening a course material the user selects a profile that has been already assigned to this course material. Initially, for a course material without any markup, the system creates a new, empty profile for this course material and displays the first slide.

Markups always refer to a particular item of a slide and can either contain:

- an annotation, i.e. an additional note of the knowledge consumer (text, link or media element)
- a personal link (see also figure 2 (e)), i.e. an additional link to any object within SCHOLION or a reference to a WWW-element
- a layout, i.e. a change of text layout within the slide, namely to highlighted (see also figure 2 (a)) or underlined text

a question, i.e. a special kind of note pointing to an entry in a discussion.

Figure 2 shows the GUI for adding a new annotation referring to parts of the text of the presented slide. The arrows in

figure 2 show some of the features of SCHOLION with respect to annotation:

- annotation through highlighting text
- hiding annotated text through icons
- marking text to which the current annotation
- an action referring to permanently displayed annotation
- personal link leading to another slide or WWW-site.

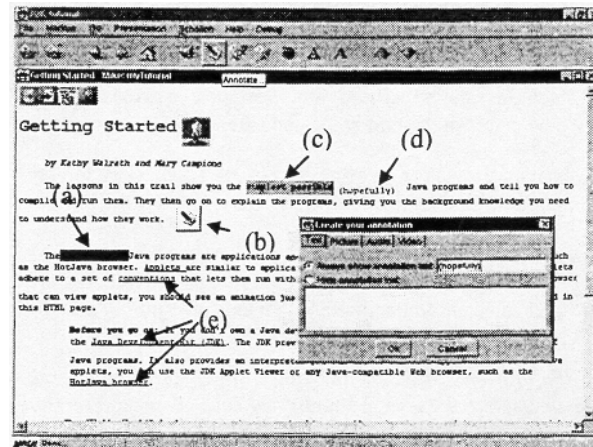


Figure 2: Adding an annotation

The *question concept* enables users to (i) mark a specific position in a slide, (ii) post a question, and (iii) additionally link the question to a discussion theme from the system's global discussion board. The latter link may guide the user to the adjacent discussion of the loaded course material.

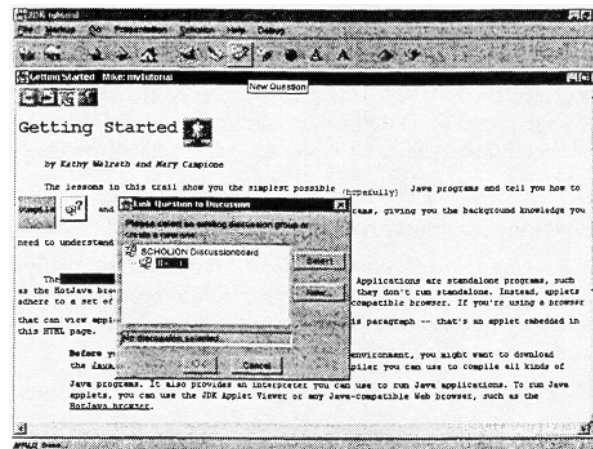


Figure 3: Posting a question onto the slide referring to a previously marked text

Figure 3 shows the GUI for posting a question onto a slide referring to a certain part of the text of that slide. The question itself has to refer to a discussion that either already exists or has to be created at this time. When creating a new discussion a new comment has to be created which automatically contains a link back to the exact position of the corresponding slide. If an user then browses the discussion board and replies to the question, this link leads to the exact posi-

tion of the certain slide where the question first came up, in order not to lose the context of the content.

In case of real-time online connections (such as through 'talk'-features), the questions and answers can pop up immediately and simultaneously on the displays of all connected users. In addition, the pages or slides referred to can be displayed at the same time, including an interactive pointing facility.

There exists a discussion board that is responsible for the administration of *discussions*. Discussions (topics) can be created either manually by the user or triggered by asking a question (see question concept above). A discussion contains a vector of contributions, being part of a certain discussion group. As each contribution leads to opening up a particular SCHOLION browser window and might be annotated just like the course material, each contribution needs to contain its location and a vector of the related contributions.

In addition to viewing slides, a playback of original talks (split up into reasonably short sequences) can be provided according to the *presentation concept*. The markups of slides are synchronized with the playback of audio files. A presentation is part of a course material containing mediatriggerers. The timestamps provided by the mediatrigger contain information about the time when a slide, a markup or other media (audio, video, picture) is started.

Users might add and delete bookmarks to a user-specific bookmark list. In addition, in order to search certain contents, there exists a predefined index for each course material. It contains a list of keywords which refer to specific positions in the course material. The list can also be extended by the user saving the changes within the user profile. The system also records page and link usage or the frequency of markups. Such statistics might be useful for the creator of the document, in order to spot places in the document which should be improved due to the identified misunderstandings.

### 3.2. Implementation Issues

Due to the fact that SCHOLION is developed further for non profit purposes, additional constraints have to be met with respect to the last mile: (i) low-bandwidth PC-connections without permanent online connection. (ii) Knowledge consumers should not have to provide broadband communication or video equipment to interact with SCHOLION. (iii) Public domain software should be used whenever possible.

Since SCHOLION is supposed to be a platform independent and easy to access educational environment, certain requirements had to be met in the course of implementation:

In order to provide the possibility of a worldwide, distributed access to the course materials the Internet is considered to be a prerequisite for end users. This way, SCHOLION can be considered to be a low-cost application working with a low bandwidth connection that is available and affordable for all Internet clients/users.

In order to implement a distributed system via the Internet, the client/server architecture of SCHOLION as shown in figure 4 has been programmed in JAVA. The listed opera-

tions and data items refer to those listed in the requirements- and design section.

The SCHOLION server administrates the access to course materials as well as public profiles. The server also enables knowledge producers to save modifications of course materials. Additionally, the administration of the discussion board is handled by the server.

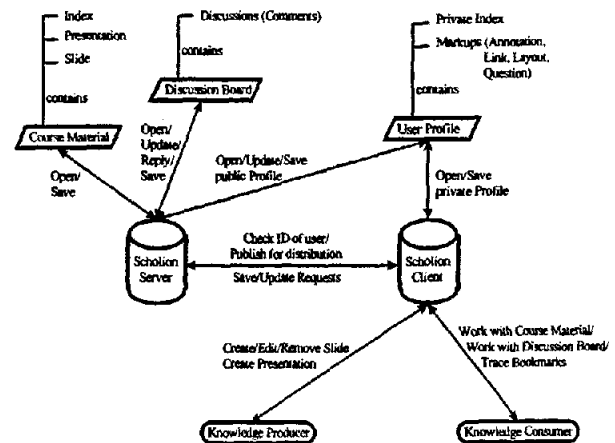


Figure 4: SCHOLION architecture

The SCHOLION client provides both categories of users (knowledge producers and knowledge consumers) with various functionalities depending on their privileges. Therefore, knowledge producers are provided with the functionality of creating/updating course materials and presentations, whereas knowledge consumers are only provided with features to individualize their profiles with respect to a certain course material.

### 4. CONCLUSIONS

Based on the evaluation results of existing approaches to support user-centered teleteaching and -learning, as described in the previous sections, and somewhere else, such as mentioned in [15], SCHOLION should increase the limited acceptance of distance learning environments and materials through the provision of the following features:

- to allow the knowledge consumers to individualize the course material in a way similar to the way they use to make notes in traditional course materials
- to provide several ways of interaction and feedback among knowledge consumers and knowledge providers. Although most of the educational environments provide such features, we try to capture the context and background of questions and answers. Advanced annotation concepts should directly link questions to the concerned course material.
- to support browsing the material according to individual annotations, and to provide replays of original presentations.

Becoming aware of the need for the universal accessibility of teleteaching and -learning environments we started the SCHOLION project, targeting towards the individualization of knowledge and the learning process through annotation and communication (on a low cost basis). As a result, knowledge producers can be provided with deeper understanding of acquisition problems learners have as well as communication facilities enabling individual contacts. Knowledge consumers might link existing materials to the provided one, and exchange context-sensitive knowledge with producers and other consumers.

SCHOLION has to be considered as a truly interactive learning environment supporting teleteaching within wide area networks. The developed prototype enables to create, browse and extend hypermedia course and training material concerning individual needs. Since SCHOLION has been developed in JAVA, the dissemination of the created materials via an open platform can be guaranteed. We will continue our research with case studies in the field of teleteaching at the University level, in order to improve the implemented concepts.

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