

# Personal Information Enhancement for Education

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## ABSTRACT

The Sidewalk project is developing superimposed tools for use by faculty and students in classroom and research settings, with a particular emphasis on use with digital libraries. One aspect of many of these tools is their support for *Personal Information Enhancement* (PIEnh) in an information space. In this paper we consider both the “additive” and the “subtractive” nature of PIEnh, with examples from course settings. We then examine several of the tools we have developed, from the point of view of information enhancement, and briefly present some preliminary evaluation results.

## 1. INTRODUCTION

Sidewalk (<http://datalab.cs.pdx.edu/sidewalk/>) is a collaborative effort of researchers at Portland State, Villanova, and Virginia Tech to expand the use of superimposed tools by both faculty and students in traditional, textbook-based classes as well as in more research-oriented, readings-based classes at both the undergraduate and graduate levels. *Superimposed tools* make use of *superimposed information* – information placed over one or more base sources – in order to annotate, excerpt, link, classify, restructure, and reorganize that base information. The basis for this work has been the SPARCE middleware [4], which supports *marks* into regions in a variety of base document and data types (such as Word, Excel, PowerPoint, PDF, HTML, audio, video and images), and which can access content and context of marked regions. Our special focus has been base sources that are managed in digital libraries, particularly those aimed at supporting STEM education.

## 2. PERSONAL INFORMATION ENHANCEMENT

The tools we are developing are largely aimed at constructing personal views of an information space, both by instructors and by students. While these views may be shared with others, they generally reflect the perspective of a single individual. Constructing such a view is not a mechanistic process (as with, say, a database view definition). Rather, it involves judgments about elements of the information space, such as filtering to the germane parts of a document and supplementing the existing material with additional information not available in the original sources, such as comments, links, and structure. We term such activity Personal Information Enhancement (PIEnh), and attempt to support it with our tools.

Note that PIEnh can involve both elaboration and selection – that is, enhancement can be additive or subtractive. Consider the following examples from our domain:

- Additive: A professor analyzes a lecture topic, works out the main learning objectives, and determines the dependencies between them. She represents this information as a directed graph whose nodes are connected to relevant groups of lecture slides or sections of the text.
- Subtractive: A student working independently on a research paper or thesis might identify relevant excerpts from other papers, filtering out extraneous segments.
- Both: A student (or small group) builds a concept map of a chapter of a course text (an active-learning strategy we have found beneficial). He selects material that defines or illustrates key concepts (selection), but also adds relationships between those concepts (elaboration).

The Sidewalk project is exploring a range of superimposed tools that support enhancement of a personal information space through both selection and elaboration.

## 3. TOOLS FOR PIEnh

We have been producing superimposed tools for PIEnh in education by adapting existing superimposed applications, adding superimposed information capabilities to existing software, and creating new tools from scratch. We describe some of those efforts here.

### 3.1 Active Strand Maps

Figure 1 shows an Active Strand Map (ASM). An ASM allows an instructor to create her own “guided tour” through material associated with a given lesson. It is based on the strand map model used in the AAAS “Atlas of Science Literacy” [1]. A strand map organizes a topic into learning benchmarks, and uses a directed acyclic graph to indicate the dependencies between those benchmarks. The 2-D layout of the graph organizes benchmarks into thematic strands. The strand map in the figure was prepared for a unit on schema refinement and normalization in an introductory database course. The benchmarks labels in it summarize learning objectives for the unit. (For example, the label “Functional Dependencies (FDs)” corresponds to “Functional dependencies (FDs) for relational tables are a generalization of the notion of key for a table.”) This strand map is laid out with practical techniques on the left, and formal concepts on the right.

An ASM augments a normal, static strand map with marks to relevant materials that address each objective. The ASM shown in

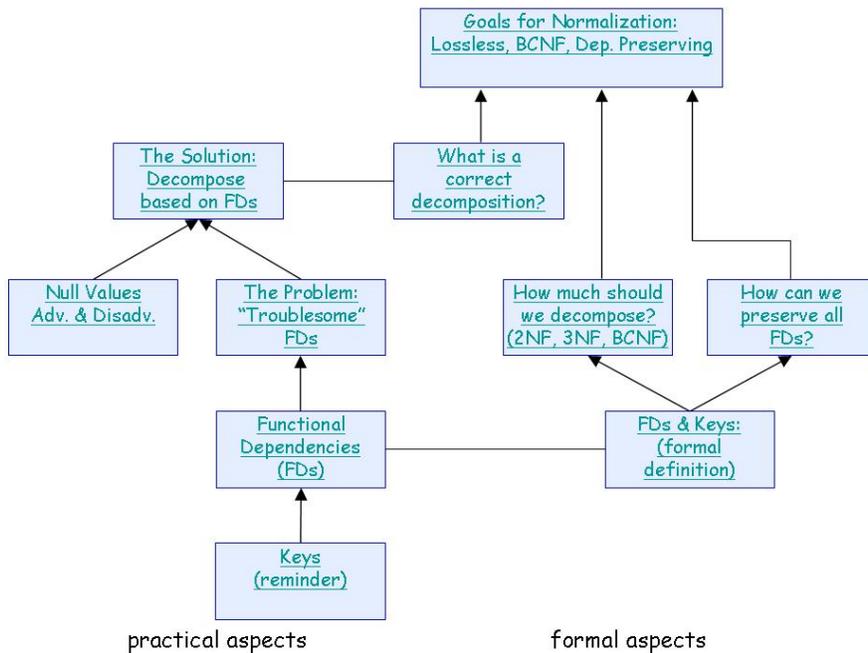


Figure 1: Active Strand Map for lecture on schema refinement and normalization

Figure 1 links to ranges of slides for the various objectives, and can be used to navigate to those “mini-lectures”. In classroom use, the instructor will typically return to the strand map between each of these sections, using it as a guide for orienting students to the progression of topics. Section 4 presents some initial evaluation of ASMs in the classroom.

An ASM is a mainly additive form of PIEnh, supplementing a lecture with a “road map” of the topics therein, but not removing portions overall. We also are working on ASMs that mark appropriate sections of the course text, as an out-of-class study aid for students, which might then involve subtractive PIEnh.

### 3.2 Sidepad

Figure 2 shows a superimposed application called Sidepad (<http://sparce.cs.pdx.edu/apps/Sidepad/>). Sidepad is a simple, scrapbook-style application with a superimposed information model based on *items* and *groups*. Each item has a label, a comment and a mark into a base-layer information source. A group has a label and can contain items and other groups. Items and groups can be placed freely within a Sidepad document. However, the interpretation of position and placement – other than containment – is up to the user. A Sidepad user can activate a mark to display the marked region in its original document and application, or can view content and context (for example, containing paragraph, column heading) from within Sidepad.

A typical use case of Sidepad is a student preparing the related-work section of a research paper or thesis. As he reads about other approaches, he can mark key passages and add comments. He can incrementally classify and organize the related work via labels and groups. When writing the related work section, he can refer back to the Sidepad documents, using activation or context access to see a marked passage and its surrounding material. (Sidepad also supports a *bi-level query* facility [3] that supports transforma-

tion of base and superimposed information. That facility can be used, for example, to create an initial HTML or Word document based on a Sidepad document.)

Thus, a Sidepad user is able to enhance his personal information space both through selections via marks, and through elaboration, using labels, comments, arrangement and grouping. We are undertaking an initial evaluation of Sidepad with high-school students. They are using Sidepad for an unstructured, research-oriented task, namely to gather and organize information for their science projects.

### 3.3 Extended IMHC Tools

We have had positive experience using the IMHC CmapTools [2] with individual students and small groups in regular courses. For example, students build and compare concept maps of chapters of the course text to enhance understanding of key concepts and how they are related.

CmapTools already allows for one or more web resources, identified by URIs, to be associated with a concept or a link. This feature supports connection to a whole document or web page. We have developed a URI-based form of marks, so that elements of a concept map can be associated with subdocuments and other fragments of base-level information [5]. For example, Figure 3 shows a concept map for digital library terms. A URI-based mark associated with the concept “hypertext” references a passage in an HTML document related to that concept. A concept map thus can become an alternative, non-linear organization for information elements in a chapter or on a topic.

A concept map with support for marking supports both additive and subtractive enhancement of information in a space. The concept map itself is clearly an elaboration of base material via an explicit graph calling out concepts and their relationships. URI-based marks, on the other hand, let a student select the most relevant portions of the underlying material.

## 4. PRELIMINARY EVALUATION

The Sidewalk project includes activities to assess the usability and usefulness of PIEnh tools in various course-related settings. We give one example here. Various versions of the ASM in Figure 1 have been used during lectures on normalization in the graduate database class at Portland State University. For one of these offerings, students were given a questionnaire at the next class meeting regarding the use of the strand-map model to organize lecture materials.

Figure 4 summarizes results from some of the items on this questionnaire. Students responded positively in general to the use of a strand map in this lecture, and most would consider using a strand map themselves to help explain a topic. The survey was given at the very next lecture after the strand map presentation, before any test or homework covering the material in it, which may explain why few students reported using the strand map on their own to

review lecture material outside of class. We are refining our evaluation techniques to try to separate the benefits of the strand-map model per se from the navigational aspects of ASMs.

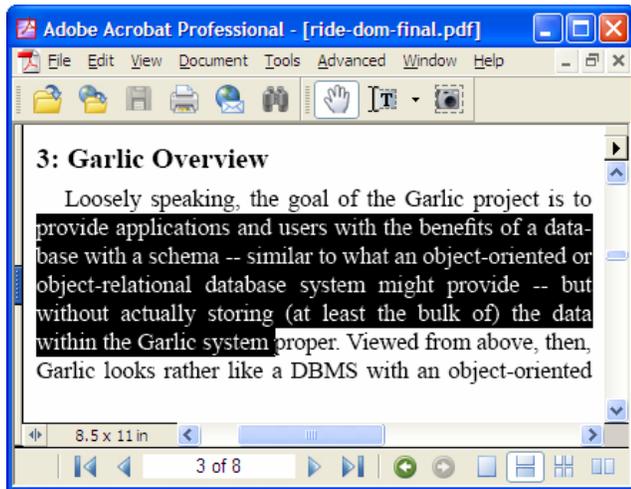
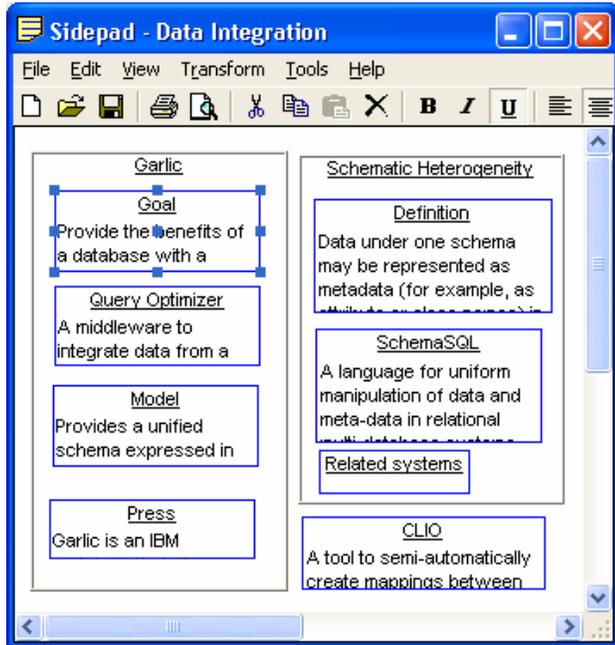


Figure 2: Sidepad document (above) showing items and groups; mark activated in context (below)

## 5. DISCUSSION

Personal information enhancements could be supported by other means that do not involve superimposed information, such as cut and paste, or even by paper-based methods. Using our tools is not without some cost; at a minimum it requires the SPARCE middleware to be running locally or on a network-accessible machine.

Are there benefits of an SI-based approach to PIEnh? Some possibilities:

- Unlike cut and paste, it is relatively easy to track an excerpt back to its original source, in order to examine context or to revise the selection (for example, by enlarging it).
- It may enable working with materials, such as course texts, where copyright considerations limit replication of material.
- A user could “cross navigate” from one PIEnh tool, to a base selection, and thence to other enhancements of the base element, either in the same tool or in a different one. While none of our applications directly support this capability currently, it is a fairly immediate extension using our bi-level query facility.

We expect to evaluate these possibilities further during the remainder of the project.

## 6. ACKNOWLEDGMENTS

The Sidewalk project is supported by NSF grant DUE 0435496.

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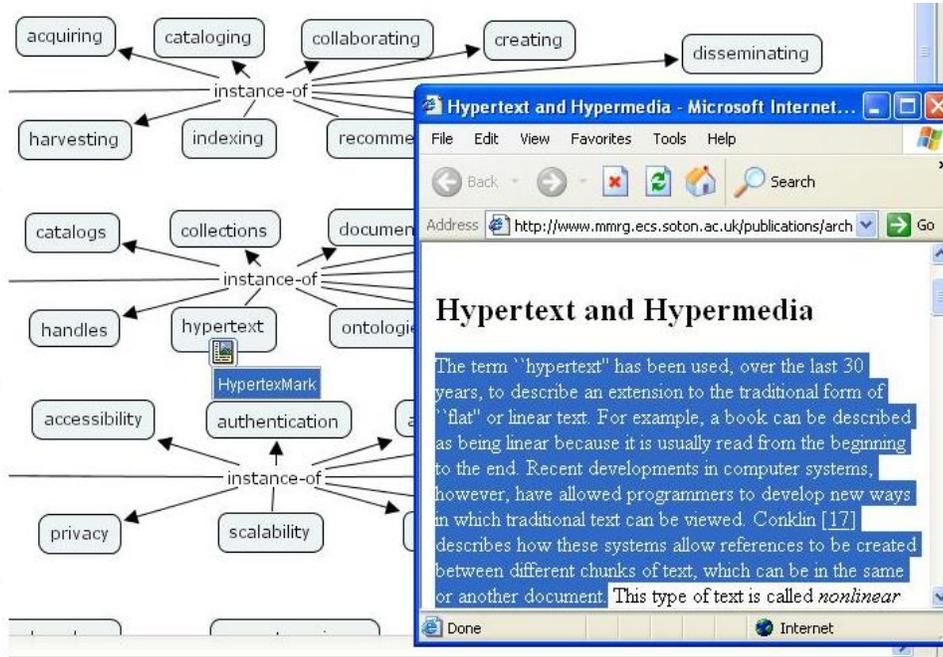


Figure 3: A section of a concept map on "Taxonomy of Digital Library Terms". The concept "hypertext" has a mark attached that points to a section describing hypertext in an HTML document (shown highlighted)

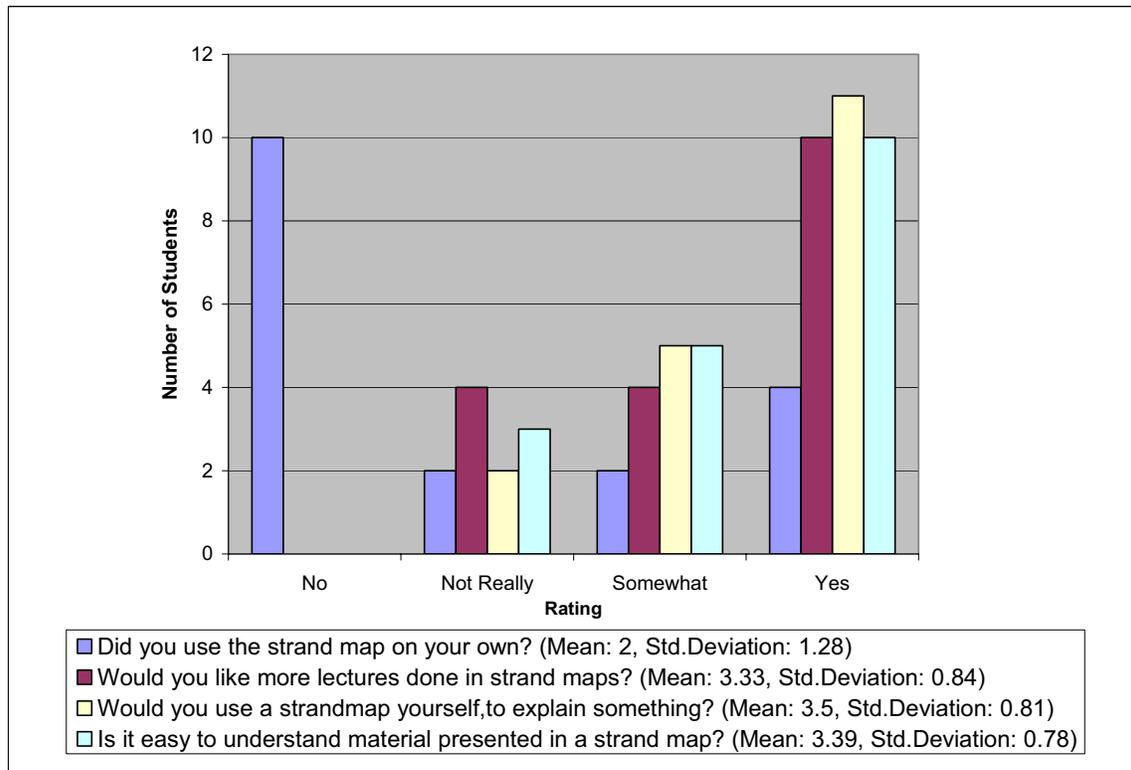


Figure 4: Responses regarding the normalization strand map lecture