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Designing a Search User Interface for a Digital Library

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The author describes some of the challenges, decisions, and processes that affected the design and development of the search user interface for Version 2 of the Digital Library for Earth System Education (DLESE; www.dlese.org), released July 29, 2003. The DLESE is a community-led effort funded by the National Science Foundation and is part of the National Science Digital Library (NSDL).

Background

The Digital Library for Earth System Education (Digital Library for Earth System Education [DLESE], 2001) is a community-owned and governed electronic library offering easy access to high-quality resources that facilitate a systems approach to learning about the Earth at all educational levels. On a more technical level, it is a distributed system of Web-accessible, highly structured metadata records that describe educational resources. It also includes a body of information structured less formally that supports the broader context of use by visitors to the library. Since its inception, DLESE has employed a practice of "bottom-up" design. It evolved from formal and informal usability studies, use case scenarios (DLESE, 2000b) submitted by the community (more than 100 collected thus far), and formal studies of users' workplace situations. Early in the design process, we engaged members of our community by studying their work and online search practices first-hand to ensure that the design would support their work situation and habits (Davis & Dawe, 2001; Weatherley & Weingart, 2000). We compiled the descriptions of what these users wanted to do into a set of representative tasks and periodically, as the design began to take shape, users were asked to perform similar tasks to ensure the library was answering their needs.

Recognizing that as technology changes, work practices and visions of the library also can change; therefore, we conduct regular studies of the usage and usability of DLESE. This helps to ensure that as DLESE grows, it remains accountable to its user base. During recent library development, we conducted focus groups with user constituencies and studied the actions of users performing specific, search-oriented, authentic tasks using different versions of our search system. The use case scenarios, along with combinations of heuristic evaluations, cognitive walkthroughs, user testing online, and think-aloud testing in our usability laboratory, combined with usability conventions (Garrett, 2003) informed our design decisions and produced several iterations of prototyping that preceded each major release of the library.

Multiple Use Contexts

Three broad challenges face this library and the resolution of them directly influences how effectively the search user interface connects users with what they seek. The first of these, and arguably the most important, is supporting a search within the immediate context of the user. The major use contexts and users of this library are described fully in our use cases (DLESE, 2000a). Here are some examples, the first three representing the primary contexts of use:

- Design all or part of a course: Kim needs pedagogical help and instructional material for teaching global climate change and deep time. She will find materials and evaluate them based on accuracy, quality, content suitability, and the degree to which they meet academic standards.
- Prepare for class: Jeff wants to spice up a lecture he is giving in an hour and a half on environmental issues of greenhouse gases and ozone depletion. He browses online repositories he knows for pictures, charts, animations, or interactive tools to use during the class. He wants to conduct a pre-screening of sites for suitability and note the locations of these materials for his students, so they can study it further. The materials he uses must be from a source he trusts and be usable without a lot of alteration because there is little time.
- Isolated educators seek online professional interaction with faculty elsewhere: Lyle is a Community College teacher

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researching paleoclimatology to prepare himself for a class exercise. This topic is outside Lyle's area of expertise. Because his school is small, he seeks information and help from faculty at other schools.

- Professional development: Dr. Todd will take over teaching a class in global climate change to sophomore geology students. He seeks to know more about this topic and what others who teach it are doing in their classes, and he may need help finding resources.
- Contribute to the Library: Cheryl wants to suggest resources about natural disasters to DLESE. Bert wants to develop a service for visualizing data in the library.
- Explore teaching methods: Alberto wants to disseminate his materials to the geoscience education community and receive support, recognition, and feedback from a community of experts in his field.
- Collaboration: Valerie would like to discover local teacher's programs, and collaborate with other classes.
- Finding funding: Art, the well-known oceanography teacher, is committed to implementing new materials for his class. He is very interested in discovering new ways to obtain a funding stream that will allow him to maintain, upgrade, and improve the materials as technology changes.
- Student doing a research project: Chris is an earth science student who is doing a project on El Niño.
- Resource creation support: Tom wants to develop online educational materials for his first year class in Geology and needs help.
- Preservice teacher assistance: Phyllis is a university senior preparing to be a kindergarten through 12th-grade (K–12) science teacher. She wishes to stay abreast of current pedagogical research, to find online teaching materials that meet the National Science Education Standards, and locate professional development news and opportunities near her.

Examining these use case scenarios reveals numerous contexts of use, the need for quality resources measured in various ways, and a wide scope of content with varying levels of granularity. Taking the first use case scenario, contexts of use, we see represented educators from all levels, students, resource developers, codevelopers, preservice teachers, etc. These users assume various roles and have varying time constraints to complete their tasks. Some are teachers assuming the role of student; others are looking for funding, or help to create learning materials. This wide set of contexts, coupled with the need to find suitable quality resources among an enormous body of content, presents a considerable challenge.

In the recent release of the library, we implemented a search methodology of contextual refinement. To start, the interface offers a way for the users to establish their primary context of immediate use. For example, they may pick one tab that says "Educational Resources," or "Educator Area," or "News and Opportunities," or use the dedicated search box on the page. Based on which option they choose, we offer one or two more levels of recognizable vocabularies of topic areas to define their search progressively. This method further refines a keyword search, and supports those wishing only to browse without entering keywords at all.

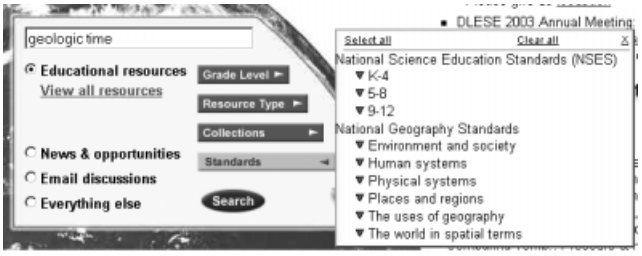

FIG. 1. Portions of the new DLESE homepage and search criteria selection are illustrated.

Let's take an example of an eighth-grade teacher looking for a resource to use in class on geologic time that meets a standard set forth in the National Science Education Standards. How might the teacher select the criteria for a specific search? Figure 1 illustrates portions of the new DLESE homepage and search criteria selection. The first contextual refinement is done when the user enters a keyword and/or selects one of the four search criteria buttons. The teacher might type "geologic time" into the keyword box, then click the Standards button to further specify his or her search.

The panel of additional selections appears to allow selection of the desired standards. Clicking a grade level under the National Science Education Standards presents a final level of search refinement.

While this may guide some users to a more targeted set of results, our studies indicate that contextual refinement will not be used by everyone, or by the same person on every visit. A few users will be particularly adept at designing intricate search queries. The majority will use a single keyword or two and hope for the best, perhaps making one obvious refinement before clicking "Search." One advantage of having multiple ways to search is that it accommodates newcomers as well as experienced users without requiring complex knowledge of search query techniques or special vocabularies.

Quality of Resources

The second challenge is making the page elements that indicate the relative quality and value of resources obvious and clear to the users so they can make informed selections. The library serves a wide and varied user base that includes educators and students at every level in both formal and informal educational contexts. A significant portion of this user base comes from either K–12, where teachers must meet various levels of formal educational standards, or from higher education, where the information in a resource is held under particular scrutiny, preferably peer-reviewed, and where the source of information must be reputable. The results from a search of the library, then, must reveal whether and to what degree resources have met various recognized educational standards for content and pedagogy as well as which have been reviewed to some level of peer-level acceptance. The challenge is compounded by the possibility of having multiple reviews for a resource.

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Our approach to this challenge is twofold. First, trained personnel who are science professionals themselves catalog each resource, and refer to a rigorous set of best practices (Ginger, 2000) and controlled vocabularies; this is followed by a quality assurance process. Then, a search engine is tuned to accomplish a search on any combination of the resulting metadata. The search interface organizes the vocabulary to aid the user in a context-sensitive, use-appropriate search. A set of annotation records associated with a resource exposes related resources and, potentially, other measures of quality and value. The search results are weighted so that the resource descriptions that use the keyword most often are given rank priority. These techniques improve the probability that a user will find a contextually appropriate resource.

Content Scope

The third challenge for the search user interface is that of handling the enormous breadth of content in a library for earth system education. In this article, I discuss two of the many parts to this challenge. Traditionally, science about the earth was taught in relatively disconnected, specialized disciplines, e.g., meteorology, geology, hydrology, biology, etc. Recently, the approach to teaching these topics has become one of merging the disciplines into a discussion of the part each plays in the Earth as a cohesive system. One approach to this challenge is to establish an accepted vocabulary to describe (and ultimately, to search) resources in this context. The community of DLESE has begun this process, but it has proven particularly difficult on several levels. Details of this effort are beyond the scope of this article, but it is a problem for the search interface when the user-educator is mandated to use this new earth system teaching approach but the resources are cataloged, and thus searchable, only by specific scientific discipline.

Another part of the challenge of handling the breadth of content is that the library consists of a great deal of information that is (a) not cataloged, (b) somewhat less structured, and (c) does not lend itself to the same process of metadata-based discovery. Members of the DLESE community participate as contributors to and codevelopers of the library, and as such, create important text-based components that describe, for example, the link between science research and education. The product of these efforts often results in a set of Web pages or services that deal with things like community news and opportunities, pedagogical assistance, best practices for using data in the classroom, how to create and submit a collection to DLESE, evaluation of educational resources, writing a review for a resource, and services for collaborating with one another. Searching for and displaying results for this kind of information that are appropriate to the users' context of finding a suitable education resource, for example, creates a significant technical and interface challenge.

The search user interface (UI) in the previous version of the library provided two separate search options. One created an index of content from the multiple sites of DLESE and performed a text-based search looking for the keyword provided by the user. There was a "site search" keyword input box provided for this purpose. A search of the cataloged (metadata-based) resources used a different keyword input area on the same page. Our studies show (not surprisingly) that this dual search option causes confusion for the user. In the latest release of the library, we have taken steps toward integrating the two search options so the user experiences a more integrated search across all of DLESE's local and remote Web pages as well as over the library's education resources. A future version will integrate the results further and incorporate a sorting feature so users can order the results according to their immediate search context. Usability studies show that imposing an organizational structure to a Web site that is not keyed to the user's context is less usable (Carroll, 2003; Nielsen, 2000). Finding all resources that match the desired query across all collections and subdomain sites of the library is preferable, we argue, to making the user seek them out on separate sites.

Best Practices

The design and development of the DLESE search user interface is guided by the following practices; they may be considered for other search projects involving metadata-based resources combined with Web content and data services.

- *Informing the design:* The design of DLESE's search user interface is based on the results of focus groups, user interviews, and observation of users' actual work practices. This body of information informed a set of representative tasks that guided design and user testing. An iterative cycle of increasingly more refined prototyping, user testing, and design modification guided development of the library.
- *Flexibility in design:* In terms of the user interface, we offer multiple options for searching. The UI supports a simple keyword-only search, and many types of key phrase searches. The design provides for refining a search by offering a set of search criteria selection panels containing controlled vocabularies against which the resources are cataloged, and hence, discoverable.
- *Integrating search and browse activities:* For the user, we took initial steps to meld the experience of searching and browsing. The user sees only one keyword box that is used for searching cataloged resources and for searching Web site (HTML) content and other databases (e.g., news and opportunities). This approach lifts the burden from the user to discern the difference between searching and browsing. The use of the keyword box is optional when looking for a cataloged resource.
- *Presenting the results of a search for cataloged (metadata-based) resources:* The context of a search also influences the user's decision-making processes when presented with a list of possible search results. In the DLESE UI, the user can see at a glance clues to the quality and reliability of a resource and the degree to which an educational resource is associated with educational standards—all things educators demonstrated to us are very important to them.

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- *Language of controlled vocabularies:* DLESE uses controlled vocabularies developed in conjunction with researchers and our educator audience but more work in this area needs to be done. The library is a forum for education reform in earth system science but the associated community of researchers and those in discreet science disciplines pertaining to the earth do not agree on terminology from which a usable ontology can emerge. Differences in ways of knowing and discussing common concepts of the earth sciences need to be resolved. Future search UI designs of DLESE will integrate such ontologies as well as information described in different formats, different metadata schemas, file types, and data and collections located at various host locations. When this happens, and as we are able to know more about the immediate search context of the users, the search results will become even more valuable and themselves be situated in a context surrounded by links to pertinent, peripheral resources available to the user.

As a community-initiated and community-driven endeavor, DLESE welcomes all ideas for implementing a consistent and coherent user experience that pervades all services the library offers. We seek to be responsive to a wide user base and to explore ways to contextualize library searches without overburdening the user.

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