Designing a User Interface for a Geoscience Digital Library

CSCI 6838 User Interface Design
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1. Introduction

A major community-wide effort is underway to build a distributed Digital Library for Earth System Education (DLESE) over the next several years. The primary goal of the library is to serve science educators and students by making excellent and appropriate digital resources easily accessible to support learning about Earth system science. The Geoscience Digital Library (GDL) identifies the first two years of the DLESE project, during which time library prototypes will be built and tested. DLESE is funded primarily by the National Science Foundation (NSF) and the design effort is focused at the DLESE Program Center (DPC) housed at the University Corporation for Atmospheric Research (UCAR) in Boulder, Colorado.

The study reported here is contributing to the early stages of the GDL user interface design. It presents the results of a task-centered process [10] of designing one prototype user interface. The design is derived from interviews of eight potential library users and the tasks they perform in their daily work environments to obtain resources for teaching and learning.

This report describes the task-centered approach as it applies to this project. It introduces potential users and their work habits, considers successful design approaches, chronicles the iterative process of design and testing, and concludes with suggestions of future enhancements based on evaluating actual user tests.

2. Task-centered Design Approach

A user interface is usually understood to include things like menus, windows, the keyboard, the mouse, and in general, all the information channels that allow the user and the computer to communicate. But in a sense, no matter how well they are crafted, the interface will be a failure if the underlying system doesn’t do what the user needs, in a way that the user finds appropriate. In other words, the system has to match the users’ tasks [10]. That is why we focus on “task-centered” design.

Our approach follows Lewis and Riemann’s Task Centered Design Process [10]. Here we summarize what we did during each activity, and the impact of doing so.

2.1. Determine who will use the library.
We selected a user base from a list of types of library users identified during formative workshops of DLESE in order to fit the scope of this project. Our user base centers on undergraduate and community college geoscience faculty and students.

2.2. Identify representative tasks that will drive the design.
First, we developed a questionnaire of web usage and a suite of interview questions for faculty and student interviews (See Appendix A & B). Second, we interviewed members of our identified user group to learn how they would use the library in their everyday teaching and learning lives. We recorded all the interviews for later analysis. Third, we summarized these interviews and questionnaires to collect all the information from our first-hand materials. Finally, we analyzed the knowledge and distilled some typical user tasks (some of them are used as design tasks, and the others as test tasks.)

2.3. Don’t reinvent the wheel – Plagiarize.
We investigated several web sites of digital libraries to guide us, and to understand the advantages and disadvantages in the user-interface designs [8].

2.4. Rough design.
Based on the knowledge gained from the former steps, we created sketches and discussed on the white-board. This activity was a culmination of all the work to this point.
2.5. Think about it. Anticipating strengths and weaknesses.
Without users, we, the designers, assessed the interface design in light of the user tasks using the techniques of cognitive walkthrough and heuristic analysis (See Appendix H). Doing such an early evaluation without users helped identify and correct blatant mistakes and oversights that users would not have to waste time uncovering.

2.6. Create a mock-up or prototype.
We created an interactive mock-up using Click2Learn's Toolbook II Instructor. It did not include a working database, but used instead a set of prefabricated results for tasks we prepared for user testing. It represented a testable entity and a platform around which further discussion and iterative design could take place.

2.7. Test it with users.
We asked our interviewees to perform several search-based tasks with the mock-up. We encouraged them to think aloud, and recorded the processes for analysis. We summarized what needed to change and what worked well, which can be used in the next iteration.

3. Interview Results Summary

Based on previous work done by UCAR researchers to identify GDL users, interviews we conducted, and questionnaires completed by those we interviewed, we determined the characteristics of a typical user of the GDL. Users are K-12 teachers, undergraduate, and graduate professors, students of all ages, who seek information and/or teaching materials on the subject of geoscience. That scope was too broad for our small research project, so we chose to limit the design of our GDL interface to college professors teaching first year geoscience students, and to first year undergraduate students. We also included an interview with a secondary target user, a middle school teacher. While our focus for this project was at the university level, the larger scope of the GDL includes K-12, so we felt this data would have value at that level.

The goal of the interview process, in addition to identifying our characteristic user, was to understand the current process instructors use to find material for their classes, and how the GDL can fit in with current practices and facilitate resource discovery. The interviews were very revealing, as we were able to watch instructors and students perform searches on the web and observe what digital tools they found most useful, and where their biggest frustrations lie.

The educators we interviewed are characterized in the following table, based on key interview questions and findings. The table identifies ten characteristics based on how educators use the web and how they locate educational materials. Only educator interviews are included in the following table. Three first-year undergraduate students were also interviewed, but the majority of the interviews and the most pertinent findings were with instructors so that will be the focus of this discussion. Further study of student research methods would be an important follow-on project.
The interview results and their design implications are summarized into the following four points:

3.1. The technical level of instructors varies broadly.
This is no surprise, as it is probably the case in most parts of society, but it implies that the GDL must be supportive and useful at many different levels. Some instructors used the web to find an occasional photo to augment their class lecture, while others developed entire on-line courses or surrounded their entire curriculum around real-time data retrieved over the web.

Design Implications: The user interface of the GDL must be easily accessible for those who want to quickly find something to augment their class, but must also provide a much richer level of support for those who want it.

3.2. Instructors do not like to do “cold” searches on the web.
The resounding reason for this is the tremendous amount of material on the web, and the general lack of quality material. The search engines did not do a good enough job and demanded too much work on the part of the instructor to filter through the results. Instead, instructors went to sites they were already familiar with; these might be colleague’s sites, or ones they discovered through a workshop or conference, or well-known, trusted sites like NASA and USGS.
**Design Implications:** 1. Knowing the source or creator of the resource is very important in evaluating the quality of material. 2. Instructors need as much help as they can in determining the quality of the resource (i.e. displayed evaluations, ratings, etc.).

3.3. Instructors perform very simple searches.

In general, they used one or two keywords, and occasionally more keywords to refine the search based on the quality of the first set of results. This is frequently a tedious and frustrating process. This is related to the above point, that instructors are not satisfied with the quantity and quality of results that are returned.

**Design Implications:** The user interface must support this type of search since it is the most common and habitual way instructors perform searches now. We also observed that this is often the only type of search supported by popular search engines, so users may be unfamiliar with the process and power of doing a more structured search. Thus we need to support the users’ current behavior, while at the same time educating them on how to maximize the quality of the results. We can encourage them to perform more structured searches, through indicating things like resource type, grade level, and resource creator; we can also support iterative refinement techniques. The question remains, however, whether an interface can institute a change in user habits.

3.4. Instructors like to browse.

This finding was not universal, as some instructors never looked at the categories provided at a search engine while others found them necessary. One instructor preferred to browse through a list of categories rather than type in a keyword, and another explained that the browsing helped her when she was not sure what she was looking for.

**Design Implications:** The GDL must support browsing as part of the resource discovery mechanism.

4. User Tasks

The following tasks were extracted from the interviews above and other sources of research. They are grouped into three suites; primary, test, and future. Primary tasks identify fundamental uses of the library and play a major role in the design of the prototype. The test suite may include some of the primary tasks but as a group they tend to be situated orthogonally to those in the primary suite. These tasks are ideal for testing the scope and flexibility of the design. Future tasks are those outside the defined scope of this project but that may be primary tasks to consider in the larger GDL and DLESE projects.

4.1. Primary Task Suite

4.1.1. Locating materials

Adam teaches an introductory undergraduate geology class. He wants to find a few photographs taken by the Sojourner of the surface of Mars and compare them to similar geographical areas on earth for his class. He wants to give these images to his graphics department to make into 35mm slides. He knows that he needs images that are of high quality and high resolution for the best clarity. But he’s not sure what resolution would work the best. He wants to preview them online, and download them, unfettered by copyright restrictions. When Adam finds the photos, he wants to remember where he got them so he can easily find similar materials again, or share the site with students.

4.1.2. Professional development

Carlye is teaching a first-year college Earth Science class and wants to create an animation that demonstrates how metamorphic rocks are formed over time. She has never created an animation before. She wants to learn what animation tools and resources are available and evaluate them. She will be looking specifically for tutorials on the tools available.
4.1.3. Augment a class
Terry frequently incorporates real-time weather data into his classes. He likes to engage students by referring to current events in weather, like the tornado watch in western Texas. He gets all his real-time data through UNIDATA, which is a national supplier of weather data. However, he would like a place where he can find interactive components, case studies, and examples of basic learning concepts associated with this data. He wants a “one-stop-shopping” place where he can access many different types of data easily and simultaneously so he can find things quickly to incorporate into his current-event based lectures.

4.1.4. Browsing for ideas and Information
Mary is a high school biology teacher who is teaching a unit on the human genome, and would like to find teaching material on DNA. She is not exactly sure what she is looking for: mostly she wants ideas and examples of things other teachers have taught. She would like to be able to locate material based on educational level, as she finds the enormous wealth of information on the Internet overwhelming and unorganized. She would also like to see suggested subtopics and related topics when she searches for DNA, to give her ideas about the direction she should take in teaching the material.

4.1.5. The design priorities arising from the Primary tasks are:
- Searching for resources (people, discussions, places, events, models and materials for teaching/learning, professional development opportunities, large data sets and tools, etc.)
- Ensuring appropriate results of a search (correctly targeted and qualified)
- Providing quick access to and management of previously successful searches/resources for re-use and sharing (search tracking, bookmarking)
- Performing multiple tasks from one central location – a notion of “one-stop shopping”
- Presenting links to related materials and some pedagogical insights based on query parameters

4.2. Test Task Suite

4.2.1. Usability Task 1
You would like to find a few photographs taken by the Sojourner of the surface of Mars for your class. You know that you need images that are of high quality and high resolution, so that you can turn them into slides later. You would like to preview them online, and download them.

4.2.2. Usability Task 2
You are teaching an 11th grade biology class. You are teaching a unit on DNA and how it works. You want some animations demonstrating how DNA replicates.

4.2.3. Usability Task 3
You are interested in finding out about the affect of sound traveling through ocean water has on gray whales.

4.2.4. Usability Task 4
You want to find material to teach your sixth grade students about tornadoes and hurricanes at a sixth grade level.

4.3. Future Task Suite
These tasks were reserved for testing at a future date.

4.3.1. Contributing to the library
Jack has developed a Java applet that facilitates his first year geology students’ ability to dynamically visualize geological relationships. It runs on a web browser. He wants to submit his applet to the library for other professors to use and he seeks academic recognition from a review
panel and would like feedback from other professors who use the applet so he can improve it.

4.3.2. Professional Development Task
Joanna is an earth science teacher who is holding a workshop in Denver for meteorology teachers on how to use UNIDATA tools. Workshops are a common way for professors to get together and spread the word about new teaching resources, so she would like to get as many colleagues to participate as she can. She would also like to get information about meteorological education societies, at the state and national levels, to give them information about the workshop.

4.3.3. Textbook abstracts for students
Aaron is a non-science major taking a freshman survey course in Geology and wants to know which geology books to start with for a research project. Aaron is overwhelmed by the number of geology books in the geoscience library and wants to know why each of them would be good. He wants to know which books cover which topics and to what detail - all in a simple description. In particular, he is interested in metamorphic rocks, and he wants to know which books would be best for him to read more about them at an introductory level.

4.3.4. Augment a Class
Tom is teaching an undergraduate geology class. He needs to find arguments against a "Young Earth Theory" to stimulate discussion in class.

4.3.5. Locating materials
Faye is an undergraduate Earth Sciences professor. She needs to find a map from the Middle Ages to incorporate into a colloquium that she is giving.
5 Rough Designs & Prototype Development

User needs: Simple and Categorical searching
Accommodates users of differing search habits, preferences and proficiencies by providing a simple text box in which to enter a keyword, or a series of selectable topics, and search parameters to help refine a search.

User needs: Quickly find materials using steps that are clear and logical.
Initial screen has only 4 numbered step labels:
1. Select area
2. Select type of science
3. Select of enter keywords
4. Select form of resource
A space for instructions, explanations and examples help guide the user. The lists themselves do not appear until needed. As each step is completed, the new query component refines the query and determines the content of the subsequent lists in order. The search modification in this design is built into the query process. User can return to try a different approach.

User needs: Support for returning to previous successful searches quickly and easily. The library provides a customizable space where search queries can be kept and managed. This is made possible by the Save Search function. (And the Load Previous Search function not shown at right.)

User needs: More information about a resource besides a title. It should provide a description or abstract, the source URL, information about the form it takes, copyright, dates, the ability to specify spatial, temporal characteristics, educational standards and quality level.

User needs: Pedagogical support for integrating technology into classroom, best practices, etc.

This design helped us to realize that we needed to narrow the scope of our project.

Design 1 – Digital library search

Figure 1
Rough Designs

This is another approach to selection-style categorical searching. This also illustrates the use of instructions and explanatory text.

Results of a search in this design also return specific data about the resource including a way to view it and download it. The design provides a way to refine the subsequent search based on the query choices made.

Design 2 – Digital library search

Figure 2

Photographs from The Sojourner: Mars

The Sojourner photographed Mars between Sept. 22, 1996 and December 4, 1996. These images fall into the following categories:

- Surface
- Atmosphere
- Weather
- Other landscapes
- Other regions
- Polar ice caps

Please select one or more categories.

Please select one of the following options:
- Download Data
- Request CD Rom containing data
- View All Thumbnails of Represented Images
- View List of Images

Figure 3
First Prototype – Search pages

The prototype emerged from discussions over the rough designs. While the library itself is meant to be available over the Internet, the prototype was created in an application that does not run on the web. The program used is Click2Learn’s Toolbook II Instructor and is somewhat interactive and fairly easily testable. No database was created for this prototype and therefore some of the design search methods were not implemented as specified in this prototype. In addition, there was little information from the interviews upon which to base the groupings and contents of the search lists.

The library effort at UCAR was proceeding in parallel with establishing metadata specifications. Metadata is key information about a resource, such as when it was produced, the author, the dates within which the resource is situated, the type of resource is it, etc. They had resolved some of the issues of the contents of search lists. Since our time on this project was constrained, we decided to adopt and adapt their schema in our design.

For this prototype, we abandoned the dynamically updating search lists in favor of UCAR’s schema of logical groupings of static selection criteria for searching. These groupings are represented by the six buttons in the left side of Figure 4.

An attempt was made for the opening screen of the categorical search to be clean and inviting to avoid confusing the user. As the cursor rolls over each of the buttons, an explanation and example of what the button does is displayed below the buttons to help guide the user. No information superfluous to the expected function of the screen at this point in time is present. This design element stems from the minimalistic design philosophy [9] and is consistent with the attempt to minimize confusion.

When the user clicks “Choose a subject”, a list representing general geoscience subject matter is displayed, and so is an area where the search can be adjusted further to specify time or spatial qualifications to the sought information. It also allows the user to select a level of review to accommodate the user’s desire to control the quality of materials acquired.

User needs: A way to track the search progress and when a successful query is made, to save it so it can be quickly found later. The Search Tracker provides ongoing feedback about the query in progress and can be saved like a bookmark for future use.

The user proceeds down the search buttons as necessary to sufficiently describe the item sought. Figure 6 shows the keyword input field and the spatial adjustment tool.
First Prototype – Search pages

Figure 7 shows the third type of adjustment for level of review. This was designed to meet the need of the users to manage the quality of materials they use in their classes.

Figure 8 illustrates the selections for type of resource desired. This was designed to meet the need of the user to specify results that are of a specific type, e.g. Animation, Course, Homework exercises, Maps.

Figure 9 shows the list of selectable file formats. While this may not meet the need of a casual user, it accommodates the advanced user who must have information in a specific file format.
First Prototype (continued)

Figure 10 is an entry field for a user to specify a known source of information. Users interviewed frequently remarked that they favor sites that have been recommended to them by trusted colleagues or at events such as conferences or workshops. The Save Search feature supports this propensity by allowing the user to save the search and to share it with others.

Figure 11 shows the selections for specifying an educational level, or materials that meet national standards. The educators we interviewed expressed a desire to find and use “grade-appropriate” materials in their classrooms. This selection criterion is an effort to meet that need.
First Prototype - Results page

The first prototype presented results and details of individual returned resources all in one display. The upper portion was scrollable (but not implemented in the prototype) and showed two full records of resources returned. For each resource it gave the site name (title), a brief description, the URL and, if it was a resource that could be viewed, a thumbnail of the resource.

The lower portion was a space for details to be displayed about each resource.

Figure 13 shows the information displayed when the user clicks the hyperlinked Site Name. It supplies all the details present in the resource’s metadata as entered at the time the resource was submitted to the library. Note the Micro search list that is a list of links inside the resource’s URL for information specific to the user’s query.

The Search Tracker is present here to supply feedback to the user on their search, and also the buttons to stop and modify their search.

In the bottom portion are scrolling list boxes of additional support for the educator, as indicated was desirable in the interviews. Educator tips support the teacher by presenting query-specific tips to help them in their jobs. Specifically, it is here that Carlye (in one of our tasks) might find resources about how to create animations of metamorphic rock formation for her class materials. Related topics is a list of topics gathered in real-time based on the query.
After Cognitive walkthrough testing of the first prototype, some changes were made to the results section. The results section was expanded to display more resources at one time. This facilitated browsing the results and comparing one to another. A Type column was added to make the type of resource more apparent. Interviews suggest that educators tend to have some particular type of resource in mind when they do searches. A legend button explains the acronyms.

Another change that is not reflected here is to change the label “Site Name/Source” to “Title” to minimize ambiguity between the two hyperlinked text areas for details about the resource and the actual URL of the resource.

Figure 15 shows the resource details appearing in a popup window. This window can be sized by the user and moved to any position on the screen. Now the information space and thus the potential for details about the resource are scaleable. On the web, both windows can be scrolled for virtually unlimited information.

This change meant that the Modify search and Save search buttons had to be located on both the resource list screen and on the resource details screen to allow the user to make changes from either screen.

The series of buttons at the top of the screens are stubs for the additional library functions that this project does not address. However, the prototype does present an explanation of what is planned for each of these areas.
6. User Testing & Results

As with our prototypes, we designed our user testing around the core functionality for our application: searching and browsing. We began by writing a task list describing four tasks for each user to complete using our prototype. Each task involved a search with widely divergent variables, in the hope of getting the user to exercise a majority of the features in the categorical search option of the prototype. With our task list, we also sought to give each user a uniform test experience.

We used for testing the fairly high fidelity Toolbook prototype described previously in the Prototype Development section. We gave the prototype enough functionality to allow users to complete their tasks successfully with a categorical search, including one result page for each of the four tasks. The prototype had little functionality outside the flow of performing a categorical search.

We tested our prototype with three users, a graduate student in computer science, a high school science teacher, and an undergraduate professor in geology. We will refer to these users as P1, P2, and P3 respectively. Testing for users P1 and P2 was performed on a computer in the office of a team member. We decided on this testing environment for users in Boulder because it was quiet and free of distractions. In addition, our prototype required the installation of a run-time environment, which we felt most comfortable doing on our own machine. Given more time, we would have tested our prototype with a few more users.

We began each user test by briefly explaining to the user the purpose of our testing and reassuring them that problems they experienced were due to the prototype, not their abilities. We also asked each user to think aloud as they completed each task—to tell us what they were trying to do and why and, if they encountered problems, what they were expecting to find, what was unclear in the prototype, etc. A summary of this script can be found at the top of Appendix D. We then gave each user the numbered portion of the task list that can be found in Appendix D, allowing them to see only one task at a time. Actually, user P1 was given a slightly incorrect version of this list, containing one task that could not be successfully completed (the prototype did not implement any relevant results to the task). This mistake was quickly remedied for users P2 and P3.

User P1 is a power computer user whose field of expertise (computer science) does not directly relate to the domain of the GDL. User P1 had the most difficulty completing the tasks, which may have been due to a lack of domain specific knowledge. He wanted to begin each task by performing a simple search using a few key words relating to the task. Only after discovering that the simple search was not implemented, did P1 try a categorical search to perform the tasks. Our prototype contained six categories of information to specify, and user P1 was initially uncertain as to whether all or only some of the categories had to be specified. He assumed that he probably had to specify all of the categories and proceeded to do so. Initially, it also was not clear to P1 in the subject category that more than one subject could be selected from the subject list. User P1 spent a great deal of time scrolling through the subject list and reading each entry to find an appropriate subject. P1 did not ever use any of the buttons beginning with an alphabetical letter to skip to a section of the subject list beginning with the given letter. For quite a long time, user P1 did not notice the search tracker box in the lower right corner of the screen. User P1 would begin new searches without clearing out the information specified in a previous search, which, in one instance, led to incorrect results. User P1 also mistakenly thought that the search button for the simple search could be used for the categorical search. On the page to view the results of his search, P1 suggested that the URL of a site should be included with the window providing more details on a resource. Finally, user P1 suggested that “Site Name/Source” was a confusing label for the title of the resource in the results page.
User P2 is very familiar with computers and the GDL domain. She seemed to have a fairly easy time in completing all the tasks with the prototype. She too wanted to begin most tasks by performing a simple search and only moved to a categorical search upon finding the simple search not implemented. User P2 also did not see the search tracker box, nor did she clear it when performing searches for new tasks. User P2 found the labeling of the ‘Save Search’ button below the search tracker box to be unclear, and suggested using the label ‘Bookmark Search’ instead, as this was a label more familiar to most users. User P2 was unclear as to what the ‘Library Identifier’ label meant, nor was she sure what type of data she could type in the ‘Identify source of information’ category text box. On the results page, user P2 provided a large amount of useful feedback. She noted that our help button was placed inconsistently between pages, making it harder to find. She liked that we specified the media types of each resource, but found herself clicking on the legend often to discern the one to two letter abbreviations. She thought that meaningful icon would be much easier to use. She also thought that it would be useful to sort results on the type field. Upon clicking on a resource and viewing details on the resource, she suggested that a link to the resource be included in this window, as well as an abstract and key words for journals.

User P3 is an experienced computer user, who was able to accomplish the task list fairly easily. He tried to perform a simple search first in performing his tasks, and wanted to find out data about the resolution and quality of pictures, which was not provided by the prototype. He also did not notice search tracker right away. When he noticed data from an old search in the search tracker, he still did not clear the data in search tracker. User P3 had a hard time finding the button to load a previous search, which he attributed to the look and placement of the button. He also did not use the ‘adjust search’ box on the right even when he understood how it worked.

The results from the user testing are summarized in Table 2 below, highlighting key problems found in our prototype and for whom each finding was a problem. In general, we found the user testing to be very useful, giving us many insights that were unanticipated, but major. We are very glad that some of these problems were discovered at the prototype level.

<table>
<thead>
<tr>
<th>Problem</th>
<th>For Whom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wanted to use simple search</td>
<td>P1,P2,P3</td>
</tr>
<tr>
<td>Not clear if all categories must be specified</td>
<td>P1,P2,P3</td>
</tr>
<tr>
<td>Not clear if more than one of subject category can be specified</td>
<td>P1,P2,P3</td>
</tr>
<tr>
<td>Read through all items in scrollable list, without using the buttons to skip to first letter of desired entry</td>
<td>P1,P2,P3</td>
</tr>
<tr>
<td>Search Tracker is not very visible</td>
<td>P1,P2,P3</td>
</tr>
<tr>
<td>Search Tracker is not cleared for new searches</td>
<td>P1,P2,P3</td>
</tr>
<tr>
<td>‘Site Name’/‘Source’ label is unclear</td>
<td>P1</td>
</tr>
<tr>
<td>Which search button is for simple search, and which is for categorical search</td>
<td>P1,P3</td>
</tr>
<tr>
<td>Difficulty finding button to load previous search</td>
<td>P3</td>
</tr>
<tr>
<td>Links to resource should be in resource information window</td>
<td>P2</td>
</tr>
<tr>
<td>Library Identifier label is unclear</td>
<td>P2,P3</td>
</tr>
<tr>
<td>Wants abstracts and key word information for journals</td>
<td>P2</td>
</tr>
<tr>
<td>Help not in consistent location across screens</td>
<td>P2</td>
</tr>
<tr>
<td>Meaningful icons for resource types easier to use the one or two letter abbreviations</td>
<td>P2,P3</td>
</tr>
</tbody>
</table>

Table 2: Summary of results from think-aloud user testing
7. Future Work

As a result of our user testing, we found many problems with our prototype, both large and small. In order to respond to the many problems, we have proposed many changes to our prototype. For the sake of brevity, we only describe the five changes to which we give the greatest priority. The proposed changes are given, as well as a rational behind the change. A more complete listing of all the proposed changes and rational can be found in Appendix F. For many of these changes, we would want to develop another prototype in order to test the effectiveness of the changes with users.

1. In the GDL front page, change the labeling for ‘Categorical Search/Browse’ to ‘Power Search’.
   **Rational**: In the GDL library, the simple search is much less likely to yield desired results for users, yet this is the type of search that all of our users initially selected. The change in the labels is to better convey the likelihood of success for each type of search, in an attempt to persuade users to go with the ‘Power Search’ in most cases. It is not certain that the changing of labels will be effective, as many users seem conditioned to use simple searches; only further testing with this change in place can ascertain any effectiveness.

2. In the initial categorical search page, eliminate the numbers in front of the different categories for refining a search, and instead use the huge open space on the initial screen for a short set of instructions on specifying a categorical search.
   **Rational**: It was unclear to our test users if all or only some of the categories must be specified to refine a search. The numbering in front of the categories seemed to imply that specifying categories was a series of ordered steps that must be completed. Also, instructions in a difficult to miss location should help to clarify such confusion.

3. Rearrange the layout of the categorical search pages. Move the ‘Begin Searching’ button to the place occupied by the ‘Load a previous search’ button, and the ‘Load a previous search’ button to the left of the simple search option. Move the search tracker and related buttons to the place in the lower left that was occupied by the ‘Begin Searching’ button.
   **Rational**: It was obvious that users did not notice the search tracker feature, nor the ‘New search/reset’ button below it—this led to some deceptively incorrect searches for users. To give the search tracker a place of greater prominence, we want to move it to the left side of the screen. It also seems more natural to place the ‘Begin Searching’ button below the possible categories to specify, as it is the button pressed once the desired categories are completed.

4. In the results page, change the label from “Site Name/Source” to “Resource” or something else, so that it is not confused with the URL source.
   **Rational**: One user expected this to take him to the URL source, rather than popping up a ‘details’ window.

5. In the window providing details about a result resource, provide a link to the resource.
   **Rational**: Otherwise, users have trouble figuring out where to actually get the resource. If they do figure this out, they have to move back and forth between windows.
8. Conclusions

After performing the user testing on the prototype we realized that there is still a significant amount of work to be done before this user interface is ready for use. There were many problems with the interface that we discovered while trying the interface against real users. Many of these problems pertained to the complexity of the GDL search engine and some pertained to the powerful, but hard to use, features we provided.

Many of the users wanted to use the simple keyword search for the user tasks. However, we did not implement that area of the prototype. Since we wanted to test the categorical search of the prototype, we had to direct each user to that area of the prototype. Clearly, we need to make the differences between the two types of searches more clear. It was difficult to do so in the current prototype due to the large amount of complexity we included into the prototype.

There were also limitations to the technology of the prototype tool. Aside from a few bugs that always returned the same results, we could not do all the things we wanted too. Some of the features of the web site that we wanted to test could not be tested because we didn’t have the ability to do those things in the prototype.

We could definitely iterate several more times on the prototype that we have or actually generate a whole new prototype to address what we discovered about the current user interface. One significant improvement to the prototype would be to hook up a working database so users may type in real search parameters and get dynamic results. This would allow realistic testing on different parts of the interface. This would require more users and more time. However, we are out of time for this semester.

We could also benefit by considering a wider set of design alternatives. Our prototype assumes the use of technology above and beyond HTML (with dynamically changing lists, pop-up windows, etc.), and this introduces usability and accessibility issues. We may want to consider a version of the prototype in pure HTML, to explore whether or not its limitations are significant in our design.

We may also want to consider providing more support in our query interface, using methods of iterative refinement and query by reformulation (Fischer et. al). These methods involve constructing and refining queries based on retrieval cues, and critiques of past queries. These methods are based on the idea that query specification is a difficult task, especially when the target data is not simple text, and that queries improve through refinement.

Another approach to the query interface could be to provide an agent to the users. This might be in the form of a small cartoon-like character (in the spirit of the MS Word paperclip). The agent could assist the user by making recommendations in the query process, answering questions, or providing relevant information on demand, like related topics or related resources.

We have only begun down the road to a fully developed GDL interface. The scope of GDL alone makes this an incredibly large task. Some of the areas that we did not address are the community discussion area, tech support, submissions to the library, customizable areas on the web site, professional development, and educator assistance.

The experience of creating a user interface from scratch seemed a daunting task at the beginning of the semester. After completing this portion of the project, it was even more work than anticipated. However, we gained valuable experience applying the task centered design process to a real life interface. We hope to have made a significant and valuable contribution to the Geoscience Digital Library project.
9. References

In developing the interview questions, and understanding the semi-structured interview process, the following references were very useful:


In performing the heuristic evaluation, the following work by Nielsen and Molich was used as our guide:


[6] We based our web usage questionnaire on survey questions from the GVU’s WWW User Surveys out of Georgia Tech. The URL for that is http://www.cc.gatech.edu/gvu/user_surveys/


The following references were used during the project for design ideas.


These are other references that were useful in the general design and development of the project.


Intertwining query construction and relevance evaluation.

Appendix A: Interview Questions

Instructor Questions

Interview Questions -- Interviewing An Instructor

0. Procedure
0.1 Write informant's name on tape
0.2 Write name on interview sheet and record start time
0.3 Zero the tape counter
0.4 Switch tape to record and aim microphone at interviewee so you can still see the tape counter: check tape is winding
0.5 Note tape counter positions at section breaks
0.6 Cross out questions as covered
0.7 Write down key points of interview immediately after over

1. Explain purpose of interview (10 minutes)
To help us understand how instructors utilize digital tools and resources in the process of class preparation and resource discovery, and how we may make this process easier. It is all confidential. We are not developers so no emotional attachment to tools or materials.
Have interviewee fill out computer experience questionnaire.

2. Planning a Class (20 minutes) Counter________

2.1 Tell us about the process you went through the last time you added material to your course. (If possible, have the interviewee demonstrate on computer)
2.2 What is involved in acquiring materials for a class?
2.3 What are your primary materials?
2.4 What other materials do you use? (i.e. other than primary)
   2.4.1 Do you usually create your own material?
   2.4.2 Do you reuse materials from other classes/contexts?
   2.4.3 How much prep time do you typically take to find or create such resources?
   2.4.4 What kinds of adaptations are required when reusing material?
   2.4.5 What is hard, and what is easy about reusing old material (i.e. what goes quickly, and what takes time and work?)
2.5 What criteria do you use in selecting material?
2.6 What criteria do you use to judge the quality and effectiveness of material?
2.7 How do you determine what you will reuse and what will be thrown away or filed?

3. Finding web sites and resources (30 minutes) Counter ________

3.1. Have you ever searched the web for educational resources?
3.2 If yes, tell us about the last time you did a search:
   3.2.1 What tools did you use?
   3.2.2 Where did you go? Why?
   3.2.3 What did you look for?
   3.2.3 Did you find what you wanted?
   3.2.4 What limitations/difficulties did you come across?
   3.2.5 How do you remember where resources are?
3.3. How easy or hard is it for you to find resources when you need them?
3.4 How much time would you spend looking for an activity for your class?
3.4 Have you ever put educational material on the web?
   3.4.1 If so, do you have material on the web now? (Interviewer: get the URL!)
3.5 Do you have favorite places to locate resources on the internet? What are they?
3.6 What do you like about each one? What do you dislike?
3.7 Describe some of the things you do to "work around" limitations of the sites
3.8 How did you find out about these sites?
3.9 Are there sites/search engines that you've used in the past but don't use now? Why?
4. What would educators like in a dig library (10 min, time permitting) Counter____

4.1 Briefly describe the geoscience digital library project, and ask what interviewee would like to see:
We are working on a project to build a “digital” library of geoscience educational material. The goal of the library is to
support educators and curricular innovation by providing access to a wide range of educational materials and services.

4.2 Is such a thing existed, would you use it?
4.2.1 If yes, would you use it if there were a membership fee of $50 a year?
4.3 Would you submit material that you developed to the library?
4.4 Would you like to see your material peer-reviewed?
4.5 Would you participate in peer-reviewing other educational material?
4.6 What are the most important areas of your job that you would like to see supported by the geoscience digital library?

5. May we contact you again?

Student Questions

Interview Questions -- Interviewing A Student

1. Procedure
1.1 Ask interviewee’s permission to tape-record the interview
1.2 Write informants name on tape
1.3 Write name on interview sheet and record start time
1.4 Zero the tape counter
1.5 Switch tape to record and aim microphone at interviewee so you can still see the tape counter: check tape is winding
1.6 Note tape counter positions at section breaks
1.7 Cross out questions as covered
1.8 Write down key points of interview immediately after over

1. Explain purpose of interview (10 minutes)
To help us understand how instructors utilize digital tools and resources in the process of class preparation and resource
discovery, and how we may make this process easier. It is all confidential. We are not developers so no emotional
attachment to tools or materials.
Have interviewee fill out web usage questionnaire.

2. Doing Research for a Class (20 minutes) Counter________

2.1 When you are doing research or need information for a class, what are the steps you generally go through?
2.2 Tell us about the process you went through the last time you researched something for a class/project.
2.3 What are your primary sources of information?
2.4 What other materials do you use? (i.e. other than primary)
2.5 How much time do you typically take to look for a particular piece of information?
2.6 What is hard, and what is easy about locating good material?
2.7 What criteria do you use in selecting material that is at the right level for your research?

3. Finding web sites and resources (30 minutes) Counter_____

3.1 Have you ever searched the web for educational resources?
3.2 If yes, tell us about the last time you did a search: (show us on the computer)
   3.2.1 What tools did you use?
   3.2.2 Where did you go? Why?
3.2.3 What did you look for?
3.2.3 Did you find what you wanted?
3.2.4 What limitations/difficulties did you come across?
3.2.5 How do you remember where resources are?

3.3. How easy or hard is it for you to find resources when you need them?
3.4 How much time do you spend looking for something on the web?
3.5 Do you have favorite places to locate resources on the Internet? What are they?
3.6 What do you like about each one? What do you dislike?
3.7 Describe some of the things you do to "work around" limitations of the sites
3.8 How did you find out about these sites?
3.9 Are there sites/search engines that you've used in the past but don't use now? Why?

4. What would educators like in a dig library (10 min, time permitting) Counter____

4.1 Briefly describe the geoscience digital library project, and ask what interviewee would like to see:
We are working on a project to build a "digital" library of geoscience educational material. The goal of the library is to
support educators and curricular innovation by providing access to a wide range of educational materials and services.

4.7 Is such a thing existed, would you use it?
4.8 What are the most important areas that you would like to see supported by the geoscience digital library?

5. May we contact you again?
Appendix B: Web Usage Questionnaire and Results

B.1 Web Usage Questions

Web and Internet Usage Questionnaire

1. On average, how often do you use your WWW browser? By this, we mean using your browser for a specific set of tasks or activities. We do not mean how many times you launch your browser per day.

- More than 9 times/day
- 5 to 8 times/day
- 1 to 4 times/day
- A few times a week
- Once a week
- Once a month
- Less than once a month

2. On average, how many hours a week do you use your WWW browser?

- 0 to 1 hours/week
- 2 to 4 hours/week
- 5 to 6 hours/week
- 7 to 9 hours/week
- 10 to 20 hours/week
- 21 to 40 hours/week
- Over 40 hours/week

3. How many hours per week do you use your computer for fun/play?

- Less than 1
- 1 to 5 hours
- 5 to 10 hours
- 10 to 20 hours
- 21 to 40 hours/week
- Over 40 hours/week

4. How many hours per week do you use your computer for your job?

- Less than 1
- 1 to 5 hours
- 5 to 10 hours
- 10 to 20 hours
- 21 to 40 hours/week
- Over 40 hours/week

5. How long have you been using the Internet (including using email, gopher, ftp, etc.)?

- Less than 6 months
- 6 to 12 months
- 1 to 3 years
- 4 to 6 years
- 7 years or more

6. What is the primary place you access the Internet from?

- Home only
- Work only
- School only
- Primarily home but also at work/school
- Primarily work/school but also at home
- Distributed/Mobile work place
- Mostly from a friend's home
- Mostly from a public terminal (e.g. cybercafe, library)
- Other

7. What do you find to be the biggest problems in using the Web? (Please check all that apply.)

- Not being able to find the information I am looking for
Creating a user interface prototype for a Geoscience Digital Library Spring 2000

- Not being able to efficiently organize the information I gather
- Not being able to find a page I know is out there
- Not being able to return to a page I once visited
- Not being able to determine where I am (i.e., 'lost in hyperspace' problem)
- Not being able to visualize where I have been and where I can go (e.g., view portions of a web site, view clickstream)
- It takes too long to view/download pages
- It costs too much
- Encountering links that do not work (i.e., linkrot)
- Other (please specify):

8. What do you primarily use the Web for? (Please check all that apply.)
- Education
- Shopping/gathering product information
- Entertainment
- Work/Business
- Communication with others (not including email)
- Gathering information for personal needs
- Wasting time
- Other

9. How do you find out about new WWW pages/sites? (Please check all that apply.)
- Books
- Friends
- Follow hyperlinks from other Web pages
- Internet search engines (e.g., Alta Vista, Lycos, etc.)
- Internet directories (e.g., Yahoo, McKinley, etc.)
- Usenet newsgroups
- Magazines/newspapers
- Signatures at end of email messages
- Television advertisements
- Other Sources

10. Which of the following have you done? (Please check all that apply.)
- Ordered a product/service from a business, government or educational entity by filling out a form on the web
- Made a purchase online for more than $100
- Created a web page
- Customized a web page for yourself (e.g., MyYahoo, CNN Custom News)
- Changed your browser's “startup” or “home” page
- Changed your “cookie” preferences
- Participated in an online chat or discussion (not including email)
- Listened to a radio broadcast online
- Made a telephone call online
- Used a nationwide online directory to find an address or telephone number
- Taken a seminar or class about the Web or Internet
- Bought a book to learn more about the Web or Internet
B.2 Results

### Web and Internet Usage Questionnaire Results

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<th>Persons Interviewed (correlates with interview summary - Table 1)</th>
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<td>Question 1. On average, how often do you use your WWW browser? By this, we mean using your browser for a specific set of tasks or activities. We do not mean how many times you launch your browser per day.</td>
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| Answer 6 |   |   |   |   |   | 0 |
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<th>Question 2. On average, how many hours a week do you use your WWW browser?</th>
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<th>Question 3. How many hours per week do you use your computer for fun/play?</th>
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<th>Question 4. How many hours per week do you use your computer for your job?</th>
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<th>Question 5. How long have you been using the Internet (including using email, gopher, ftp, etc)?</th>
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<th>Question 6. What is the primary place you access the Internet from?</th>
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### Question 7. What do you find to be the biggest problems in using the Web? (Check all that apply)

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### Question 8. What do you primarily use the Web for? (Check all that apply)

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### Question 9. How do you find out about new web pages/sites? (Check all that apply)

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</table>

### Question 10. Which of the following have you done? (Check all that apply)*

<table>
<thead>
<tr>
<th>Answer</th>
<th>x</th>
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<tbody>
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*Only 1 questionnaire included question 10*
Appendix C: Screen Shots

The following images are screen shots to help visualize what the prototype looked like during user testing.

**Screen Shot 1 - Main Home Page**

DLESE is for education professionals, students, science organizations, and the general public. We are proud that its design and creation was a collaborative effort among each of these groups working together for mutual benefit.

**At DLESE you can:**
- locate quality science educational materials quickly
- seek collaboration and participate in online community activities
- advance your knowledge of any earth science field
- discover best practices in education and analyze emerging pedagogical methods
- find support for creating educational materials
- contribute what you have to share with a wide group of peers

**Simple search**

Customize your search or browse

To start a search, you may either enter a search word or phrase and click GO!, or begin a categorical search by clicking the button above.

The buttons at the top of the screen access special services of the library and additional library help and information.

Take a library tour
Screen Shot 2 – First screen of categorical search
Screen Shot 3 – Choose a subject
Screen Shot 4 – Enter a keyword to narrow a search
Screen Shot 5 – Adjusting a search by level of review
Screen Shot 6 – Select a type of resource
Screen Shot 7 – Choose a file format
Creating a user interface prototype for a Geoscience Digital Library

Screen Shot 8 – Name a source
Screen Shot 9 – Educational level and standards
<table>
<thead>
<tr>
<th>Site Name / Source</th>
<th>Description of link</th>
<th>Type of Link</th>
<th>URL Hyperlink</th>
<th>Thumbnails</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sound in Air and water</td>
<td>Two samples of sound and dolphin</td>
<td>Audio / GR</td>
<td><a href="http://tech.museum/science/Aquatic/AquaticSound.html">http://tech.museum/science/Aquatic/AquaticSound.html</a></td>
<td>Thumbnail</td>
</tr>
</tbody>
</table>

Screen Shot 10 – General results
<table>
<thead>
<tr>
<th>Site Name / Source</th>
<th>Description of link</th>
<th>Type</th>
<th>URL Hyperlink</th>
<th>Thumbnails (if available)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>Sound in Air, and water</strong></td>
<td>Two samples of sound and dolphin</td>
<td>AU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. <strong>Marine Mammal Acoustics</strong></td>
<td>Locations of blue whale vocalizations for selected days in September, 1994, based on SOSUS acoustic detections.</td>
<td>MU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. <strong>IMML Whale Acoustics Project</strong></td>
<td>Research projects: locating whales with sound publications</td>
<td>UD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. <strong>Oceanography</strong></td>
<td>Materials on Oceanography</td>
<td>IA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Screen Shot 11 – Legend for resource type:

- **A** = Analysis
- **AU** = Audio
- **DT** = Descriptive text
- **GR** = Graph
- **I** = Images
- **IC** = Interactive components
- **IT** = Instructional text
- **M** = Map
- **MV** = Movie
- **P** = Photograph
- **RT** = Real-time data
- **S** = 35mm Slide
### Screen Shot 12 – Detailed results

**Site Name / Source**
- Sound in Air, and water

**Description of link**
- Two examples of sound effects on marine mammals

**Type Legend**

**URL Hyperlink**

**Thumbnails**

<table>
<thead>
<tr>
<th>Site Name / Source</th>
<th>Description of link</th>
<th>Type Legend</th>
<th>URL Hyperlink</th>
<th>Thumbnails</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound in Air, and water</td>
<td>Two examples of sound effects on marine mammals</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Details about the resource:**

- **SOURCE:** Sound in Air, and water
- **Library ID:** None
- **Educational Value:** None

**Micro search**
- Jump directly to these topics on the site you've indicated:
  - Dolphins
  - Whales
  - Marine mammals

**Other options**
- Data is available on this site for downloading, or for ordering on CD-ROM. Courseware is available in paper-based format or online.

**Educator tips:**
- Using photos from the web in your classes
- Making an animation from still photos for the web
- Links to helpful sites for creating web graphics
- Links to tutorial on digital photography

**Related topics:**
- Sound transmission in water
- Navigational techniques of whales
- Salinity and acoustics
- Other projects at Scripps

**Pertinent online discussion:**
- Ask an oceanographer
- NNML whale acoustics classroom

**Search tracker:**
- Whales

**Resource Type:**
- Animation, Course, Homework exercises, Map

**File Format:**
- gif, jpeg, vml, htm

**Modify search**
- Save search
Appendix D: User Testing Tasks

Script for Think-Aloud User Testing for the GDL Prototype
April 20, 2000

Prepare the user for the think-aloud:
We want the user to feel comfortable and understand that if something goes wrong, it is the fault of the prototype and not the fault of the user! We want to stress the fact that this is only a prototype, with very limited functionality. Many of the features have not been implemented. At times, we may need to interrupt an activity to help the user overcome a limitation of the prototype. We are most interested in how the user would approach the search problem – and how well the software matches their goals; not how well they can use the software.

The tasks
1. You would like to find a few photographs taken by the Sojourner of the surface of Mars for your class. You know that you need images that are of high quality and high resolution, so that you can turn them into slides later. You would like to preview them online, and download them.

2. You are teaching an 11th grade biology class. You are teaching a unit on DNA and how it works. You want some animations demonstrating how DNA replicates.

3. You are interesting in finding out about the affect of sound, traveling through ocean water, on gray whales.

4. You want to find material to teach your sixth grade students about tornadoes and hurricanes at a sixth grade level.
Appendix E: Interview Summaries

E.1 Interview with a Professor of Introductory Geology

*This was somewhat of an abbreviated interview, because of the Professor’s time constraints. So not all questions were addressed, and his responses are listed under the most relevant question (though sometimes it was hard to make that mapping!)

2. Planning a Class

2.2 What is involved in acquiring materials for a class?
I talk to people, I read books, I go to colloquia, seminars, as I learn I incorporate material that I learn that I see as being applicable in my classes.

2.3 What are your primary materials?
We have a textbook. I do a lot of different types of classes, a field geology class where the rocks are the textbook. Or an advanced course where we take rocks and analyze them. But with respect to intro level courses. . I will use two overheads, slides, videos, and sounds. It’s low-tech multi-media.

2.4 What other materials do you use? (i.e. other than primary)
Interestingly, I have tried to do things with the web in classrooms or CD-ROM, e.g. Access a website and introduce it to the students and have them go do exercises on that site. I think it’s important that students recognize the importance of using this new technology. So at least once a semester I’ll do a big lecture class with a web-based assignment. I’ll bring in a laptop and have somebody help me set it up. In the classroom this is tough thing to do, and that’s a discouraging factor for me in bringing that material into the classroom.
It’s funny, the biggest problem I have is hooking the darn stuff up. The image quality is ok, (certainly no better than a slide).

2.4.1 Do you usually create your own material?
In some respect – although its ultimately stolen from a text or somebody else’s ideas.
For example, I need some Mars images to put an interesting twist on a lecture tomorrow, so I’m getting slides from a colleague who is a Mars specialist.

2.4.2 Do you reuse materials from other classes/contexts?
None of what I do is purely created, except on rare occasion. Everything else is to some extent reused – a photograph from a textbook, taken from a web, or xeroxed. I “steal” things from other professors, books, I take slides from books, and often times off of the web. We have a guy in the graphics department who I can give a .jpeg file or a URL and he converts it into a slide for me.

2.4.5 What is hard, and what is easy about reusing old material
The only hassle would be in how fast I can get a slide made off the web or from the textbook.

2.6 What criteria do you use to judge the quality and effectiveness of material?
I feel that after teaching for 15 years, I have a reasonably good gut impression of what students find interesting. I’ve had very good instructor evaluations, so I think my statement is rather correct: I know what students are going to find interesting, stimulating, and useful. Engaging. That’s how I do it.
So if I’m reading something, or are participating in a colloquia, or see a really good film on Discovery . . . if I encounter some sort of material, I can decide whether its going to be useful or not.

3. Finding web sites and resources

3.1. Have you ever searched the web for educational resources?
Yes.

3.2.5 How do you remember where resources are?
Bookmarks (they are a mess right now)

3.2 If yes, talk about the last time you did a search:
Just a minute ago, a student was in my office who wanted to know about internship opportunities. I wanted to give him good contact information from a person at the Geological Society of America (GSA). So I went to the GSA sight, and it actually took me a while to find this person’s email, phone number, address, etc., on the site.

3.2.3 Did you find what you wanted?
There was no problem finding this URL, because you can go to any search engine and type in something as distinctive as Geological Society of America and boom it comes right up.
Another search:
Another thing I did rather recently was related to updating my vita. I was looking for information about a publication I did, like the title, journal, and page number.

3.2.3 Did you find what you wanted?
I found it, but there was some information missing, so ultimately I have to go down to the physical library and look it up. The library here provides a georeference search system that we can tap into from the web. In particular, I was using georef.

Do you still have that URL?
You know I was doing it from home, so I don’t have the links here. But you should ask Susanne Larsen, she is at the earth science library.

Another Search:
Another thing I found through the CU library: I needed, for a colloquium I was giving, a map from the middle ages – I love to incorporate historical things into my lecture. I found a fabulous map resource page on the web, in connection to the CU library. I could show you that, I bookmarked the page. I downloaded the image as a file and gave it to the graphics person to make a slide.

In general, I’m really pleased with the CU library services – maps, georef.

3.3 How much time would you spend looking for an activity for your class?
I give up relatively soon – 5 – 10 minutes.

3.4 Have you ever put educational material on the web?
Yes, class materials: syllabus, review notes. It’s remedial compared to some other things people are doing – some professors have interactive assignments on the web, real cool stuff.

Would you use these types of assignments that other professors have developed?
Absolutely. But with the caveat that I would keep that sort of thing to a minimum, because I don’t want to build a class that is so web-dependant that it loses the interaction in the lecture and lab.

3.5 Do you have favorite places to locate resources on the internet? What are they?
No, I just randomly pick a different search engine. Maybe the last search engine I remember that helped me find something, maybe I’ll go to that.

3.6 What do you like/dislike about search engines?
I like search engines that have a lot of categories to begin with, so I can pick a category. If I need to find someone at a university, and I go to say Lycos, and it has an immediate click box for education – I would click that before I type “university of Alabama.” I like categories ready to go.

I dislike the fact that I type in a couple of words, I don’t know, hit the plus key or whatever, and it just seems to miss the point. That’s frustrating.

Professor expounds on his beliefs on the impact of the web on learning:

Even though I think it’s important, I think there is quite a bit of “hoopla” about the vast amount of information that is accessible on the web. In my opinion there is WAY TOO MUCH information out there.

To me, certain kinds of concepts and ideas, not just what science is but how people do it, I think I’m much better relaying by telling a story about a real scientist, as opposed to sending the students off to the web so they can learn about 8 different rock types. Maybe they need less information and more flavor of the discipline. It worries me about trying to bring too much technology into the classroom. It’s important, but I don’t want to bring that much technology into the classroom – more is not necessarily better.

I also believe that students are not learning the ability to stay with something, e.g. sit with a textbook, and maintain their attention span. Web-based learning, web-based courses are all about a short attention span. In fact I have reviewed some web-based courses, I did a chemistry course for example, and you constantly have the mouse in hand – going to the next page, watching a video – things are always changing.

Anything students can do to increase their attention span will make them better learners, and the web does a disservice to that. There should also be less box-clicking and more writing.
E.2 Interview with a Professor of Meteorology

2.1 Tell us about the process you went through the last time you added material to your course. (If possible, have the interviewee demonstrate on computer)

The Professor teaches the Introduction to Meteorology course at Metropolitan State University of Denver. He teaches with three to four other teachers to rotate all the sections of the course. In each section, there are typically 30 to 40 students enrolled.

The Professor attempts to break free from the traditional model of having straightforward reading of standard textbooks and taking quizzes and exams. Most of the students he teaches are not meteorology majors, so he wants to make it interesting. Incidentally, there is a different introduction course for meteorology majors.

2.2 What is involved in acquiring materials for a class?

This question was not addressed.

2.3 What are your primary materials?

Before the Internet, the Professor had to rely on traditional charts, diagrams, and text books. He would illustrate as best he could on a chalkboard the meteorology data to show the students.

Now with the Internet, the Professor uses the Web and UNIDATA to show the students real time visualizations of weather across the country.

UNIDATA is a program sponsored by UCAR that distributes weather data and the software to visualize it. Most universities depend on UNIDATA because commercial real time weather is extremely expensive. The software the Professor uses specifically is GEMPAK and GARP to view weather data. He has been using UNIDATA for 5 years and he started with only one machine. Now he has an entire lab stocked with weather data workstations.

An Internet connection in the classroom is critical to his lectures. Up to 50% of class lecture time is spent using the UNIDATA information and showing weather data. He brings up real weather data to teach the class about meteorology.

2.4 What other materials do you use? (i.e. other than primary)

Some of the assignments for the class involve using the UNIDATA software. The students may create images using the GARP software and save them on the local disk. The students then can put the images up on their websites for display. The students also can submit the assignments to him using their websites.

2.4.1 Do you usually create your own material?

He creates the assignments, but sometimes uses other materials in his lectures.

2.4.2 Do you reuse materials from other classes/contexts?

Yes. He sometimes leverages materials from other colleges. He also has a list of good resources on the web.

2.4.3 How much prep time do you typically take to find or create such resources?

When creating his assignments, he is primarily concerned with the learning objectives. He asks himself if the student will learn anything from the assignment. Usually he can create an assignment in a couple of hours.

2.4.4 What kinds of adaptations are required when reusing material?

The Professor explained that he compares the created/reused material to traditional teaching methods. Then he takes the problems and applies the problems to real data.

By looking at the weather, knowing the subject, and having the facts in his head, he can adapt the material to class.

2.5 What criteria do you use in selecting material?

2.6 What criteria do you use to judge the quality and effectiveness of material?

2.7 How do you determine what you will reuse and what will be thrown away or filed?

He showed an example of a few java applets that he could potentially use in class. Thomas Whittaker created the java applets. The professor considered the applets a very good resource, but it was not enough to build an entire course around them.

He looks for something that he can use in class to teach the students. His personal opinion is the primary selection factor.

Another website he demonstrated was created by Allison Fraiser at Penn State. Some parts were good, but it was at too high of a level and required full-time student Internet access. Many of his students do not always have 24-hour computer access. Because this school’s format, there are few computer labs for the students. If the student doesn’t have a computer at home, large Internet-based assignments may be difficult to complete.
He mentioned that Rich Wagner, another teacher at UCD, incorporates a large number of Internet-based assignments for his students. According to the professor, Rich comes up with some good web exercises.

3. Finding web sites and resources (30 minutes)

3.1. Have you ever searched the web for educational resources?
He does not use a search engine. He does not use Yahoo. The results that come from such searches are generally garbage.

He wants quality sites with useful content. They tend to be few and far between. He mostly talks to other meteorology professors and experts in the field to find resources.

He also runs workshops in the summer for meteorology teachers on how to use the UNIDATA tools. It is a very common way to spread the word about online resources to his colleagues.

3.2.5 How do you remember where resources are?
He uses bookmarks on his computer in his office. He has about 40-50 meteorology bookmarks saved.

3.3 How much time would you spend looking for an activity for your class?
He does not spend much time searching for resources on the web because he usually already knows of its existence already. It is just a matter of finding it or going to the right URL.

4. What would educators like in a dig library (10 min, time permitting)

4.1 Briefly describe the geoscience digital library project, and ask what interviewee would like to see:
"There's a real need for something like that."

Is such a thing existent, would you use it?
“Yes, no question about it.” He mentioned that with something like the GDL, he could spend less time on finding/adapting material and spend more time on the learning objectives of the lecture or assignment. He conjectured that it could be used to assist other meteorology professors to incorporate technology into the classroom. It may sway some professors to overcome their fear of technology. It is very difficult to get over that barrier.

If yes, would you use it if there were a membership fee of $50 a year?
The question was not addressed.

Would you submit material that you developed to the library?
“Yes, I could.” He has no problem sharing his stuff.

Would you like to see your material peer-reviewed?
Would you participate in peer-reviewing other educational material?
Yes. However, he noted that his opinion might not apply to all the material.

What are the most important areas of your job that you would like to see supported by the geoscience digital library?
To have a home page on the web site
To get links to high quality educational material
To have access to examples of basic learning concepts
To have access to real data sets
To have access to case studies
To have access to real time data
To be able to utilize Interactive Teaching Modules
To have a list of other teachers of meteorology
To have a starting point for much of this technology
He wants categorized data immediately available and to be able to easily navigate to the correct resource.

Other Miscellaneous comments:
He is very excited about having technology entering the classroom. However, he did express some concern about the student learning the material. The Internet provides real time data instantly, instead of having to pore over endless weather data paper maps. He believes that after slowly analyzing numerous paper maps, the student would develop a 3D model in his or her head that allowed an internal visualization of the weather. With this internal model, the student was more apt to truly understand what was happening. He is concerned that a student may not develop such an internal model of the weather with such easy access to data. Essentially, there is little effort for the student to get data instantly.

Some URLs that he accessed during the interview:
http://www.rap.ucar.edu/weather
http://www.unidata.ucar.edu/
http://www.unidata.ucar.edu/community
### E.3 Interview with a Geoscience Professor

<table>
<thead>
<tr>
<th>Interview question</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2.0 Planning a Class (20 minutes)</strong> Counter 000</td>
<td></td>
</tr>
<tr>
<td><strong>2.1 Tell us about the process you went through the last time you added material to your course.</strong></td>
<td>First I choose a topic and then start looking for content. The first place I look is in my own bookshelves. Next I ask colleagues who may have books I can use, or they may have web sites I can access. The last place I look for materials is on the web.</td>
</tr>
<tr>
<td><strong>2.2 What is involved in acquiring materials for a class?</strong></td>
<td>I look for materials that are at my level and then distill the information down for my class. I don’t usually look for ready-made materials for use directly in my class. I create most of my materials myself.</td>
</tr>
<tr>
<td><strong>2.3 What are your primary materials?</strong></td>
<td>My own bookshelf. Printed materials</td>
</tr>
<tr>
<td><strong>2.4 What other materials do you use? (i.e. other than primary)</strong></td>
<td>I ask colleagues for materials. They sometimes have books and sometimes give me web URLs. I have a few web sites that I trust.</td>
</tr>
<tr>
<td><strong>2.4.1 Do you usually create your own material?</strong></td>
<td>Yes. For me, that is the best way.</td>
</tr>
<tr>
<td><strong>2.4.2 Do you reuse materials from other classes/contexts?</strong></td>
<td>About 85 - 90% of existing materials from a class the previous year is reused.</td>
</tr>
<tr>
<td><strong>2.4.3 How much prep time do you typically take to find or create such resources?</strong></td>
<td>Recently, I developed a 3 hour class. It took me 15 to 20 hours of work, most of which was research and mental exercise. Only about 3 - 5 hours was actually spent writing anything down for the class. It depends. What is the goal of the materials? And how does that goal match with my goal? I may have to adapt the intent to match mine.</td>
</tr>
<tr>
<td><strong>2.4.4 What kinds of adaptations are required when reusing old material (i.e. what goes quickly, and what takes time and work?)</strong></td>
<td>I may have to take a chart from a book, for example, but often I just make it myself.</td>
</tr>
<tr>
<td><strong>2.4.5 What is hard, and what is easy about reusing old material (i.e. what goes quickly, and what takes time and work?)</strong></td>
<td>The hardest part, and the part that takes longest is the initial reading and searching through books. Once I get to making the materials, it goes quickly. I use well-known resources. Well-known to me. They are ones I trust. If I don’t know the source, I don’t use their material.</td>
</tr>
<tr>
<td><strong>2.5 What criteria do you use in selecting material?</strong></td>
<td>I use well-known resources. Well-known to me. They are ones I trust. If I don’t know the source, I don’t use their material.</td>
</tr>
<tr>
<td><strong>2.6 What criteria do you use to judge the quality and effectiveness of material?</strong></td>
<td>Same as 2.5.</td>
</tr>
<tr>
<td><strong>2.7 How do you determine what you will reuse and what will be thrown away or filed?</strong></td>
<td>I try to keep my classes up-to-date and fresh. I like to create about 10-15% new materials from year to year.</td>
</tr>
<tr>
<td><strong>3. Finding web sites and resources (30 minutes)</strong> Counter 307</td>
<td></td>
</tr>
<tr>
<td><strong>3.1. Have you ever searched the web for educational resources?</strong></td>
<td>Yes.</td>
</tr>
<tr>
<td><strong>3.2 If yes, tell us about the last time you did a search:</strong></td>
<td>I always use MetaCrawler. It is a search engine that searches all the other search engines. I was looking for “Young Earth Theory” for arguments for a class on the age of the earth to stimulate discussion in class, and to bring in a theory we were discussing in class. [get name from tape] That’s what I typed in. I rarely use more than a word or two for a search and I never use the category breakouts you often see with search engines. I also never do Boolean searches. I am not inclined to change the way I do searches. This seems to work fine.</td>
</tr>
<tr>
<td><strong>3.2.1 What tools did you use?</strong></td>
<td>I found an interesting list of reasons why creationist theory</td>
</tr>
<tr>
<td><strong>3.2.2 Where did you go? Why?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>3.2.3 What did you look for?</strong></td>
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</tr>
<tr>
<td><strong>3.2.4 Did you find what you wanted?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>3.2.5 What limitations/difficulties did you come across?</strong></td>
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</tbody>
</table>
### 3.3. How easy or hard is it for you to find resources when you need them?

It depends. I can spend 30 minutes on the web and find nothing. I can ask a colleague or search my own resources (books) and more often find what I need. If I know what I'm looking for, I might go to the web directly. But it takes the majority of prep time, doing the research and distillation for class.

### 3.4 How much time would you spend looking for an activity for your class?

I don't usually look for activities for my class. I generally create my own. But sometimes I find activities on the web. I don't spend more than 30 minutes looking for anything.

### 3.5 Have you ever put educational material on the web?

3.5.1 If so, do you have material on the web now? (Interviewer: get the URL!)

- Introduction to Geophysical Exploration
  - [http://www.mines.edu/fs_home/tboyd/GP311](http://www.mines.edu/fs_home/tboyd/GP311)
- Exploration of Science and Engineering Laboratory
  - [http://www.xsel.mines.edu](http://www.xsel.mines.edu)
- Colorado Princeton Earth Sciences Project
  - [http://www.mines.edu/fs_home/tboyd/CoPEPP](http://www.mines.edu/fs_home/tboyd/CoPEPP)

### 3.6 Do you have favorite places to locate resources on the internet? What are they?

NASA [other one, get from tape]

### 3.7 What do you like about each one? What do you dislike?

[Regarding search engines]

- I tried using Yahoo and it found only 1 site, which was not helpful. I tried WebCrawler and it found 5200 sites! It doesn't give the URL address. I don't want to have to run my cursor over the hyperlink to see the address. I want to see it spelled out. Also, neither Yahoo nor WebCrawler give a description of the site.
- I browsed the first page or two and didn't find what I was looking for, so I gave up. If I don't find what I'm looking for in about 20 to 30 minutes, that's all the time I give it. I have better things to do with my time.

### 3.8 Describe some of the things you do to "work around" limitations of the sites

[Regarding search engines] I use MetaCrawler.

### 3.9 How did you find out about these sites?

MetaCrawler helps, but I knew of these sites. Sometimes my colleagues give me addresses.

### 3.10 Are there sites/search engines that you've used in the past but don't use now? Why?

See 3.7.

### 4. What would educators like in a dig library (10 min, time permitting) Counter____

4.1 Briefly describe the geoscience digital library project, and ask what interviewee would like to see:

We are working on a project to build a “digital” library of geoscience educational material. The goal of the library is to support educators and curricular innovation by providing access to a wide range of educational materials and services.

4.2 Is such a thing existed, would you use it?

I haven't decided yet. Maybe I would if I were teaching a first year class or a class that was outside my regular classes.
4.2.1 If yes, would you use it if there were a membership fee of $50 a year?  
NO. It should be "apparently" free. By that I mean there should be no fee attached directly to its use. However, I can understand the need to raise revenue, but the money would have to be raised in ways that don't make it look like a fee for use.

4.3 Would you submit material that you developed to the library?  
Yes.

4.4 Would you like to see your material peer-reviewed?  
Yes.

4.5 Would you participate in peer-reviewing other educational material?  
Yes.

4.6 What are the most important areas of your job that you would like to see supported by the geoscience digital library?  
I would really like to see some support for creating materials like the java applets I created, or other tools. This is a real need. Perhaps an actual support group where people could come for about 9 months and devote that concentrated time to developing something they really need. The library could supply experts in creating those tools.

5. May we contact you again?  
Sure.

E.4 Interview with a 6th Grade and High School Physical Science Teacher

2.1 Tell us about the last time you added material to your class? Tell us the steps you went through?  
Once I decide on the topic, I start by going through my own material, as I have a ton of material [at home]. Next, I look in media—the library and stuff like that. I also go on the internet, as there are some good sites that I know for educators, with good links for things like lesson plans. I'll go there and search around for useful information.

Tell us about the level you teach and how big are your classes?  
Right now, I am teaching 6th grade, Introduction to Physical Sciences, with class sizes between 27-30. For the last 3 years I taught all four grades in high school, with class sizes between 30-35. In high school, I taught Biology, Physical Sciences, and Marine Biology.

2.2 How do you collect materials?  
I make notebooks, and collect everything. I photocopy printed materials, and usually download things from the internet.

2.3 What are your primary materials?  
Activities that I make. I have the kids do a lot of hands-on stuff. When I was teaching high school, there were 5 computers in every classroom and a presenter, so we could do a lot more with computers. I would have them look for stuff online or I would find some websites and have them look for information there. I would have the kids present the information on the monitor (through the presenter). Now, I just have a computer on my desk for my use; there is a separate computer lab for students and we occasionally do activities there.

2.4 Other than that, what are secondary materials that you use?  
Books. I don’t think that I’ve ever had a class where we used textbooks. The students complain about having to carry them around, so I keep them in the classroom.

2.4.1(+2.4.2) So do you usually create your own material?  
I try to find things and adapt them to my classroom. I try to do a lot of group work as well. I find it very easy to create group work assignments.

2.4.4 Is it hard to adapt the material for class?  
There are different ways to adapt. You can adapt to different types of learning, to the different types of activities that you want to do, different levels, you can take material and rewrite it so that it is easier to understand (by taking out some of the scientific jargon).

2.5 What do you look for when selecting material? What is your criteria?  
Every school has a set of ‘crucials’ or standards that you have to teach to. You want materials that create a real life situation out of the standard to which you are teaching. For example, if my standard is that the students must understand how the weather patterns affects earth and things inhabiting the earth, I might go and find some stuff on hurricanes or tornados and how they have affected people. The students are always very interested in how things are going to affect them and people in general, on a ‘real life’, ‘real problem’ kind of basis. If you can find something showing or talking about how people are affected, like all our houses were blown down by a tornado, and this is what they had to do, they (the students) can relate to that.
What is the best thing that you’ve found that really impacts them?
A good picture helps much more than simply reading about something. Most of my students nowadays are visual learners. Also, if you can do an activity on the computers, it’s amazing. I recently used an animation program (she wasn’t sure which one) to create atoms and animate the electrons moving around. They created the animation through some simple animation program.

Do you do a lot of those assignments?
I try. There is only one computer lab for the school. I try to do 2 hands-on activities per week.

How do you judge the effectiveness of a unit?
I can do that on a daily basis just by looking at their faces and performance assessments at the end of the unit. Sometimes I will stop an activity in the middle of class if it is not working, and will think of another activity. For example, if they are writing on paper and not getting something, I may stop and have a group discussion to figure out what they don’t get. I can then try to explain a concept again.

3.0 Finding web sites and resources

Have you ever searched the web for educational resources?
Yes (already mentioned).

3.2(3.2.1,3.2.2) How do you search the web for resources?
I will type in a search look at results from the search. I will also go to sites that I already know are OK and follow links from there. They are educator’s sites, like accessexcellence.com and discovery.com. There are links at these sites for educators, and I will try to search these links. Very time consuming. On accessexcellence.com, for example, you might type in DNA for a search, and you will get back 3 pages of items that aren’t about DNA, but just happen to mention it.

When you typed in DNA, what were you looking for?
Well, it depends. Sometimes you know what you are looking for, and sometimes you are just looking around. All the stuff you get is so much more than you would ever need. It would be nice to be able to type in the ‘high school level’ or ‘college level’ or whatever, and get activities just for that level.

3.2.4 Do you ever use general search engines?
Yes. General search engines are really, really hard. You have to be sure your words are very correct. For example, I would have to type in DNA and secondary education to search for DNA. When I search on specific sites, I get better quality results. The toughest problem is knowing what to type, how to narrow a search down.

How much time do you spend looking for an activity?
5-10 hours per week.

3.4 Have you ever put educational material on the web?
No. I’ve thought about it.

When you find good sites, how do you remember them?
I add it to my favorites. I have a lot of those.

3.6 What do you like about accessexcellence.com vs. discovery.com?
There are actually a bunch of sites that I use. It depends on what type of material I’m looking for. Discovery.com is more geared towards media, that sort of thing, while accessexcellence.com is actually a collection of lesson plans that other teachers have submitted.

What do you like best about the sites that you have collected?
I know that they have good links to other science sites related to what I am teaching. Sometimes it is really hard to sift through all the material; you want to have the material pop up right away. I would be nice to enter a topic and be given a list of subtopics that you might want to look for, and be able to narrow down your topic that way. Going back to the DNA example, are you looking for the human genome or for DNA structure, or what?

3.8 How did you find these sites?
Usually through educational resources—magazines, stuff like that. Or someone else will discover a site and reference me to it.

Are there sites that you used to use and don’t use anymore?
Not that I can think of. I only change sites because my topic has changed.

4. What educators would like in a digital library

If something like the Geosciences Digital Library existed, would you use it?
Definitely. Especially at the high school level. I could use it at the 6th grade and junior high level, but in high school, for oceanography, there were a bunch of activities that I did where they had to browse for information on waves and stuff like that.
Would you use it if there was a $50 membership fee?
Ooh. That makes it tougher. If it were $50 for access for all students in the classroom and myself and the school paid for it, I would. If it cost $50 for each student that wanted to use it, then no (the school probably wouldn't pay).

Would you submit material to the library?
Sure. The reasons why people don’t is just because of the time that it takes. I’ve put some jointly developed stuff on the web, like this staged kidnapping that I worked on with another teacher at school. We called in DNA forensics experts and other people.

Would you like to see things that you put up peer reviewed?
That would be really neat.

Would you participate in peer reviewing?
Sure. I think that shouldn’t be required.

What would be the most important things for the digital library to do?
A really good search where you can narrow things down by subtopics, like I mentioned earlier. Also, an index that contains detailed subtopics. When you get to an area, it would be great to have clips (pictures or animation) to go along with the information—students get very excited about that and it’s helpful and makes things more interesting.

It would be neat if they had sites that could direct you to constant updates on different things—like meteorology. Something like the weather channel. I know you could do activities that involve graphing and analyzing, and if you’ve got current information that continually updates, that would be great. Constantly updated wave and tide information, water level, precipitation, and tracking hurricanes would also be good. There was one site that tracked a shoe to study currents, with constant updates. The same with sea turtles, to follow their migration. These are all great for activities.

Of course, getting this advertised is also probably an issue. When a flier is sent to a school, a lot of teachers will take a look at the site once, just to check it out. Once you get to word of mouth, things spread quickly, across schools.

Getting current information is the most useful information. Older information is not as useful. If you make it easier to find more current information and websites that keep updated, that would be good.

I wish there were some interactive things online. You can order some things, but you can’t try them out before you order—you need a preview of the interactive software. A neat example of a good interactive tool, would be to demonstrate water flow, where you have a stream and students can insert rocks of various sizes here or there and observe the effects on the flow of the stream. There is not a lot on the Internet that you don’t have to pay a lot of money for. Anything students can interact with is something that they will remember a lot more.

May we contact you again?
Yes. Definitely.

E.5 Interview with a Professor of Physical and Historical Geology

2.1 Tell us about the process you went through the last time you added material to your course?
I usually play around with different aspects of technology that relate to geology, get familiar with them on my own, and see whether or not they are useful in terms of improving the knowledge of my students. I go through a filtering process myself. The last example of any significance was using handheld global positioning systems. I worked with them for a summer and determined that students could actually learn important concepts of maps, so I’m incorporating that into my class.

I look for stuff that enhances understanding—whether technology or not, as opposed to things that just have bells and whistles. The other question I’m always asking: What does a real geologist do? For example, when we work with spreadsheets, How do geologists use spreadsheets? How do they use computers in general?

2.2 When you are looking for materials, what are your resources?
I’m pretty active with geological education societies (both at state and national levels). I’ve talked to many teachers across the country at the K12 level and at the college and university level and I pick up a lot of new stuff in these places. I get material from my own research as well.

Geology is a very visual science. At lot of things like the Elmo projector (a projector that can show slides, a computer screen, and function as an overhead projector) are designed so that the students can see things. I could stand up here and talk about seroterol (?) weathering and describe it, but a picture is worth more than a thousand words.

What are your primary materials that you use in class?
Slides. 35mm slides. Overhead transparencies. I typically show portions of geology videos—rarely the whole thing—that illustrate through animation some of the points I am trying to make. I use a lot of rock materials as visual aids. During lectures, I put boxes of rocks in front of the students. These boxes are put together for me by a warehouse, Wards Scientific, with the type of rocks that I specify. When I am talking about something theoretical or abstract, I tell them to pick up rock #23 to see an example of a porphorous (?). I use maps as well.
We have computers in the back of the lab (6), so students can work on assignments here, and on computer labs on campus. I do about 3 labs out of 12-15 labs on the computers. There are more and more materials on the web, but not all of them are good. I hear about sites, or I see links, and I check them out.

**How do you find these sites or who refers you to them?**
I start off with the US Geological Survey, or I’ll hear about the site in a book or magazine article, and then there’s usually links to other sites from there. I hear about stuff from other people or through my own research. Or I’ll get on a search engine and look for, say, volcanoes.

**What kind of search engine do you use?**
Sherlock—the general search engine on iMacs that access the results from many other search engines, like AltaVista and Lycos.

**Do you usually create your own material?**
I am a terrible thief. I steal ideas and adapt them to my class.

**How much time do you take to add new material?**
One answer to that question is months. I usually mother hen it to work out the bugs. Another answer is a couple of semesters. I guarantee you that there will be bugs when I try something new—I’ll revise based on those bad experiences.

**What criteria do you use in selecting material?**
Is this something that is simply taking the place of something that they can get from the book? I apply that filter. I’m looking for materials on the web that are interactive, from which they learn an important concept. Many times I have found what students learn from pretty decent exercises is the ability to press buttons and have the computer solve the problem, rather than understanding the mechanics of the problem. I type out a worksheet to go along with computer exercises that includes questions that go analyze the process the computer used to solve the problem. I want them to understand the geological principles behind any computer solution. For instance, a computer can locate earthquakes easily, but I want them to understand the data that the computer would synthesize to calculate that.

3. Finding sites and resources

**What is hard and what is easy about using Sherlock to search for material?**
I’m not sure that I’m that sophisticated of a user to have any problem with it. There have been other search engines that didn’t give me as many hits. I started off using AltaVista.

**When you search, how do you search?**
I try to get as specific as I can. I will do other iterations if necessary and will usually add words in successive iterations.

**Do you have other geological resource favorites on the web?**
In terms of bookmarks, I have the US Geological Survey. There are some earth science sites, and even one by another teacher, Dorothy Stout (http://galileo.cyprus.co.ca.us/geoaci/geostout.html). She takes the time to include on her site stuff that she has found interesting—other links and whatnot.

**How did you find Dorothy’s site?**
I met her at a summer conference and she mentioned it. The conference was STEP (Earth and Space Sciences Technical Education Project), which I attended the last two summers. It was for teachers, mostly at the college level, to acquaint them with different technologies and how to use them to become more effective teachers. It was a two week workshop, and I have become a faculty member with STEP. Unfortunately, funding expires at the end of the year (from NSF).

I am chair of the natural sciences department, so I teach 2 classes/semester. I would say that only 25-50% of students have computers at home, but there are easily accessible computer rooms in the school.

**Is there specific software that you like to use?**
I’ve looked at a lot of it. Almost every textbook comes with a CD-ROM, but by in large I have been disappointed with this. By in large, they are just visual representations of things that you can find in a book. There are a few pieces of software that I have found that are interactive and allow students to learn something by understanding a process. There are some excellent ones that Dennis Tasa has done (TASA Graphic Arts, Inc). He’s got one that really helps students learn to read topographic maps that is very methodical and well done. He also has other programs on plate tectonics and others. I wouldn’t hesitate, if a student had to be out of town and missed a lecture on plate tectonics, to give the plate tectonics application to him and he would learn the material well. I don’t make many assignments from these; I use them more as back-up material.

**What do you use your computer hookup for in class?**
Mostly for animations. I don’t use it that often, because it is being projected to a TV screen and frankly, the image isn’t that crisp. We hope to get a good LCD projection unit—we hope to get that next year.

4. What educators would like in a dig library

4.2 If such a thing existed, do you think that you would use it?
I would certainly be interested in looking at it. It would have to be cross-platform (he uses iMacs). The USGS digitized their slide library, but it was a PC specific access. I was able to, with great pains, convert the slides to my Mac, but I would not want to do that again.

4.2.1 If there was a membership fee of $50, would that be a problem?
I’d say that a fee of that amount is kind of irrelevant, but I would like to see what I am getting first. Again, I am more interested doing type of things, than just slide collections, as I have been developing my slide collection for over 30 years.

4.3 Would you submit material to the library?
Yes. I’ve done some computer animation of sedimentary processes that the students actually learn stuff from. I haven’t put it on the web, as I don’t have a web site yet. That is one of my goals for next year. I would like to put them on. I have given the animation out in a disk format and have gotten feedback that it is very useful.

4.6 What would you like to see in the digital library?
I would like more of real-time data. Flood data, earthquake data.

I see animations as a very important part of learning geology. I am sure that there are many people that can do it much better than I can (I’m no graphic artist). I would like to see as many as possible that illustrate how things form.

I would love to see things that allow students to actually work as geologists and do problem solving of a geological nature. Some computer programs can walk students through the process. Again, it needs to be more than simply learning when to push which button.

I would also like stuff in which the copyrights are not such that the materials cannot be copied or manipulated. I’ll often take the ideas of another and modify them.

We have a graphic arts program and a couple helped me out on developing some animation. That is something that I would like to continue to pursue—any help in that area would be great.

5 May we contact you again?
Sure.

E.6 Interview with a Scientist and Educator

The Interviewee is a scientist and educator looking for a graphic showing recent sea-surface temperatures, or the data set to construct a graph herself. She will use this to augment a lesson she is preparing for the American Meteorological Association’s education outreach program. She wants to find a way to narrow down her search and wants to go quickly to a resource she knows and trusts. She is hoping this task will take less than 30 minutes, but she is prepared for it to take as long as two hours. She begins by reviewing materials she already has. Since this topic is within her field of expertise, she is more confident she can find something suitable quickly. It takes longer to find good sources on subjects outside her expertise.

The material she selects must be suitable for teaching K-12 students about sea-surface temperatures. She determines the suitability of content and accuracy based on her own prior knowledge of this subject and on opinions of trusted others. She is willing to adapt what she finds, if necessary, to the point of creating her own graph based on a recent data set. Creating her own materials is attractive because she can customize it for an exact purpose.

Her online searching usually goes to places like NASA, NOAA, USGS, NWS, IMS for solid content, but they are often too large a site to begin a search on. Instead, to search, she begins with Google, a popular search engine. From the results returned from her search, she looks for these trusted sites. Once she finds a resource, she downloads it and adapts it to the lesson. When it is done, she uploads it to the AMS web site. (Datastreme project)

She frequently uses the web to search for scientific and non-scientific information. She knows about scientific sites from her training and work as a meteorologist. She would use a digital library to find materials that are already categorized to meet the National Science Education Standards for a given grade level. She would use it to help herself develop educational materials. The Library could be a sort of community center to find good materials or point to large data sets, and make large data sets easy to use. She would also use it to collaborate on the creation or adaptation of materials.

E.7 Interview with a Geoscience Student

Q: What steps do you follow when you do research?
A: It really depends on the class. If it’s a science class, often I’ll go down to the Fiske planetarium and talk to people there. They recommend web sites, like the official NASA website, things like that. I’ll use search engines too and do key-word searches. If I’m doing research for a humanities course, and need a book, I’ll go to Chinook, the university library system.

Q: Tell us about the last time you did a search. Where did you go?
A: I was looking for critical articles on the book Snow Crash by Neal Stephenson. So I went to AltaVista and typed in “snowcrash Neal Stephenson”. I got a bunch of results from bookstores and reviewers, but very few critical articles. I try to filter through the results by looking at the one-line summaries of the sites, and also by looking at the URL’s. I mean, if the website is www.bookbuys.com I know its not what I want. All of the junk on the Internet is the hardest thing about doing searches.

Q: How much time do you typically take to look for a particular piece of information?
A: I’ll spend a minute or so on a page, scroll down, if I’m sure its what I want until I give up. I’ll look at the first couple of pages of results when I do a search at AltaVista, before I give up and try a new search or add or subtract keywords to my old search – for example, when searching for Snow Crash, I tried adding “critical article,” then I tried searching on just “Neal Stephenson”.

Q: Where do you usually go when searching for web resources?
A: AltaVista is my standard. But sometimes I’ll find more specific search engines, like a search engine just for Impressionist painting for my French class. Then I’ll go there, but I’ll only go back to those specific search engines if I’m doing more research on the same topic.

Q: How did you find out about these?
A: Friends. For educational stuff, teachers and my friends at the Fiske Planetarium. Sometimes teachers give specific websites for a homework assignment – for example, in my astronomy class, we used to have to do homework assignments where the professor would give us URL’s and questions we had to answer.

Q: How do you remember where resources are?
A: If I’m at home, I’ll make a bookmark. If I’m at school, I’ll write down the URL. Sometimes I’ll print out the page. I usually don’t have trouble finding something again if I lose the URL.

Q: Are there any search engines you used to use but don’t anymore?
A: Yahoo. My friend told me AltaVista was better. And it seems like Yahoo has fewer sources and is slower.

Q: Interviewer introduces the concept and the goal of the GDL . . .Do you think you would use this resource?
A: Yes, for class assignments. If I knew about it. I would probably only find out about it through a teacher. I doubt I would find it just by searching on the web, though, I mean there is just so much out there.

Q: What would you like to see on the GDL?
A: Clear layout. I don’t like it when search engines are too cluttered or have confusing categories. The categories should be broken down well. It would be nice to have different sets of categories, like an alphabetical listing, and then historical/physical geography, etc. So if you don’t know exactly what category you want in one grouping you could still find what you are looking for.

For homework, it would be important to find articles on the material, not just pictures or animations or little interactive things. I mean, those are nice but when you are doing research or writing a paper they aren’t helpful. And I would expect the information to be very up to date.

E.8 Interview with a Geoscience Student

General expression: Student is a computer and web lover.

1. Have interviewee fill out web usage questionnaire.

2. Doing Research for a Class (20 minutes) Counter___0000___

2.8 When you are doing research or need information for a class, what are the steps you generally go through?
Answer: First, I go to the web site and keyword search to see what is related to it. That is what I used to do. If that doesn’t have it, then I will use the textbooks to see what is really matched to the question and purpose.

2.9 Tell us about the process you went through the last time you researched something for a class/project.
Answer: I picked up some keywords, and went to a search engine, and searched both of the words, and check what was returned. There were about 20 web sites that have the best match. I opened them to see if they were really matched to what I was doing, and then I picked the sites, and used them.

2.10 What are your primary sources of information?

2.11 What other materials do you use? (i.e. other than primary)
Answer: Textbooks and everything online.

2.12 How much time do you typically take to look for a particular piece of information?
Answer: Five minutes.

2.13 What is hard, and what is easy about locating good material?
Answer: Deadlinks and many pop-up windows. Otherwise, it is always easy for me to find information.

2.14 What criteria do you use in selecting material that is at the right level for your research?
Answer: I just look for the same level of communication that I can get from my teacher.
If that is at that level, I know it is the level of our research. If it is too complex, it's flying over my head, I say no way. If it is too elementary or too middle-school area, I know that's too low level.

3. Finding web sites and resources (30 minutes) Counter __060___

3.1. Have you ever searched the web for educational resources?
Answer: Yes.
3.2 If yes, tell us about the last time you did a search: (show us on the computer)
   3.2.1 What tools did you use?
   Answer: Many many search engines. If one doesn't have it, then I'll jump into another.
   3.2.2 Where did you go? Why?
   Answer: I went to http://www.google.com/, because it is very simple. I like the web site that has less images and doesn’t have too many stuffs. That’s my criteria.
   3.2.3 What did you look for?
   Answer: Open http://www.google.com/, and type the keywords “ncaa + payment + athletes”.
   3.2.3 Did you find what you wanted?
   Answer: Yes.
   3.2.4 What limitations/difficulties did you come across?
   Answer: Deadlinks.
   3.2.5 How do you remember where resources are?
   Answer: Bookmarks and files.
3.3. How easy or hard is it for you to find resources when you need them?
Answer: Very easy.
3.4 How much time do you spend looking for something on the web?
Answer: Very low. Five minutes.
3.5 Do you have favorite places to locate resources on the Internet? What are they?
3.6 What do you like about each one? What do you dislike?
Answer: I like simplicity, and don’t like meaningless items. Sometimes I like it when they go ahead and make some suggestions, e.g. http://www.excite.com/ gives some information of newsgroup.
3.7 Describe some of the things you do to “work around” limitations of the sites
Answer: Open up multiple windows.
3.8 How did you find out about these sites?
Answer: Friends tell me.
3.9 Are there sites/search engines that you’ve used in the past but don’t use now? Why?
Answer: I don’t like AOL (American Online). That one doesn’t have interface well, has problems with the plus symbol for multiple keywords.

4. What would educators like in a dig library (10 min, time permitting) Counter____

4.1 Briefly describe the geoscience digital library project, and ask what interviewee would like to see:
4.9 Is such a thing existed, would you use it?
   Answer: It depends on if it is accessible from outside of Colorado. If I can view it from my home computer, yeah I will use it.
4.10 What are the most important areas that you would like to see supported by the geoscience digital library?
   Answer: I think you need pictures and diagrams for your basic library information. This will be a little more helpful than just a bunch of texts.

5. May we contact you again?
Answer: Sure.
Appendix F: Complete List of Suggested Prototype Modifications

F.1 Location: GDL Front Page

1. Change the labeling for ‘Simple Search’ to ‘Shotgun Search’ and the labeling for ‘Categorical Search/Browse’ to ‘Power Search’.
   Rational: In the GDL library, the simple search is much less likely to yield desired results for users, yet this is the type of search that all of our users initially selected. The change in the labels is to better convey the likelihood of success for each search, in an attempt to persuade users to go with the ‘Power Search’ in most cases.

2. Reduce the text describing GDL.
   Rational: When confronted with such a large amount of text, most of our users simply skipped it, missing some important information on the GDL.

F.2 Location: Categorical Search Pages

1. Rearrange the layout of the categorical search pages. Move the ‘Begin Searching’ button to the place occupied by the ‘Load a previous search’ button, and the ‘Load a previous search’ button to the left of the simple search option. Move the search tracker and related buttons to the place in the lower left that was occupied by the ‘Begin Searching’ button.
   Rational: It was obvious that users did not notice the search tracker feature, nor the ‘New search/reset’ button below it—this led to some deceptively incorrect searches for users. To give the search tracker a place of greater prominence, we want to move it to the left side of the screen. It also seems more natural to place the ‘Begin Searching’ button below the possible categories to specify, as it is the button pressed once the desired categories are completed.

2. Eliminate the numbers in front of the different categories for refining a search, and instead use the huge open space on the initial screen for a short set of instructions on specifying a categorical search.
   Rational: It was unclear to our test users if all or only some of the categories must be specified to refine a search. The numbering in front of the categories seemed to imply that specifying categories was a series of ordered steps that must be completed. Also, instructions in a location that is difficult to miss should help to clarify such confusion.

3. Provide examples for categories in which the user can type free text, particularly the ‘Identify source of information’ category.
   Rational: A user was unsure of what could be typed in this free text—this problem would be easily solved with an example or two below the text box. A constrained list of sources would also solve this problem, and this option should be considered further.

4. Place the help button for each screen in a consistent place.
   Rational: This makes it easier for the user to find the button on every screen. We reluctantly propose to place the button in the large empty space in the lower right of our newly proposed screen layout. We would want to test this position in further user testing. It is also important to note that there is a very prominent Support button on the upper right bar of the screen—context sensitive help could be an option supported from this button as well.

5. Change the label of ‘Save Search’ to ‘Bookmark Search’.
   Rational: It was a little unclear as to exactly what ‘Save Search’ meant, while the term bookmark is a term that users are more familiar with in this context.

6. Change the help bar to instruct the user to select one or more subjects.
Rational: Users were uncertain as to whether they could select multiple subjects, and did not see the instructions above the alphabet buttons. Ultimately, we should consider dropping the alphabet buttons altogether and use an auto-complete feature to move to the appropriate alphabetical place in the subject list. Without the alphabet keys, it should also be easier to see the instructions above them.

7. Add a help comment when the user rolls over the ‘Library Identification’ text box.
Rational: It was unclear to some users exactly what this box meant.

8. Place the ‘Level of Difficulty’ slider in the ‘Educational level and standards’ category.
Rational: This was merely an oversight discovered in testing, as we only had ‘Educational standards’ in a category that was supposed to be ‘Educational level and standards’.

9. Consider reorganizing the subject list into broad categories and smaller subcategories.
Rational: It is very likely that this list could become very large, and impractical for users to skim through completely. Unfortunately, skimming through the list seems to be the method employed by most of our users to read the list. Organizing the list in more general, higher-level categories would allow users to skim only subject that are more closely relevant to their search. More specific subjects should be allowed to be in more than one general subject.

F.3 Location: Results of the Search Pages

1. Change the label from “Site Name/Source” to “Resource” or something else, so that it is not confused with the URL source.
Rational: One user expected this to take him to the URL source, rather than popping up a details window.

2. Drop the simple search option from the results page, and put the ‘New Search’ and ‘Refine Search’ buttons in its place.
Rational: We felt that there was no need for the simple search option in the results page (they can click on ‘New Search’ to perform a simple search). This option was taking up valuable, prominent space.

3. For journal articles, place a clickable abstract entry in the thumbnail column.
Rational: This makes use of the thumbnail space by providing access to information that is very useful.

4. Add a column to provide some of ranking or relevance values to the results.
Rational: Users are accustomed to this feature, and some find it meaningful.

5. In the window providing details about a resource, provide a link to the resource.
Rational: Otherwise, users have trouble figuring out where to actually get the resource. If they do figure this out, they have to move back and forth between windows.

6. Drop the search tracker from the window providing details about a resource.
Rational: It is not useful in this window, and the space could be put to better use.

In the future, we would also like to address the granularity of educator tips in the details window, as one user placed a great deal of emphasis on this feature. We might also want to make the results sortable by column feature, as one user seemed to indicate a desire for this feature.
Appendix G: Rough Design Scenarios

G.1 Sojourner Task

1. Alan enters library via URL as member of library. Alan’s preferred screen set up displays. He set this up previously. Alan is recognized as an instructor by default.
2. Alan makes selections for search:
   A. Selection box 1, Area: Locate material
   B. Selection box 2, Type of science: Land and Space
   C. Selects from appropriate set of keywords: Geologic Time, Deserts, Mars, probes
   D. Selects form of data: Photos
3. Alan scrolls through results and finds NASA missions to Mars. He selects “Photos of Sojourner”.
4. Alan clicks on Artifact to study the copyright information. He clicks on Content to study the facts covered in this photo as described by NASA’s metadata.
5. Alan clicks on Educator Tips and goes to a library site that describes how to use photos from the web in classes, suggestions for selecting an appropriate resolution and approximate download times for different Internet connections.
6. Alan goes back to the Results page and clicks the URL to view photo.
7. Alan views the thumbnail, clicks the URL, and jumps to the link.
8. He decides that one of those photos will work for his class and he downloads it, knowing that he is free to use it (no copyright restrictions.)
9. Alan returns to the search page where all his selections are preserved. He clicks Save to save the query and the library ID of the link he used so he can give it to his students. It is saved in his personal bookmark space in the library.
   A Save As dialog box pops up that allows him to specify where to save the bookmark and arrange his library space. He can also set permissions here to manage who can access his resources.
10. Alan enters the information in the Save As box and saves his query.
11. Alan returns to the search page and refines his search to look for photos of the earth that show rocks or soils comparable to the photo he found from the Sojourner (He learned about the soil/rocks in the Sojourner photo from its site and its metadata). He now does a search based on that information.

G.2 Finding animation Task

1. Carlye enters the library as a new member and chooses to create a profile and register as a library member. She clicks on GO on the first page to make a profile. The profile screen displays.
2. Carlye completes the profile questionnaire and clicks DONE. The search screen displays.
3. Carlye clicks on 1. Professional Development, skips 2, selects from Professional Development keywords, 3. Computer skills, and 4. Animation and Tutorial. Results show up below. She adds Tools to present data to expand her search results.
4. Carlye clicks on site name in Box 2.1.1 to get the link’s metadata, which appears in box 2.1.2.
5. She goes to the sites linked to learn about creating an animation and download a trial copy to evaluate.
6. Going back to the search page, Carlye clicks on Educator tips to see if it offers additional help on creating animations. It does, and she clicks Print and Save. The Save As dialog box pops up.
Appendix H: Cognitive Walkthrough

H.1 Task
Alan teaches an introductory undergraduate geology class. He wants to find a few photographs taken by the Sojourner of the surface of Mars for his class. He knows that he needs images that are of high quality and high resolution for the best clarity. However, he is not sure what resolution would work the best. He wants to preview them online, and download them.

(Distilled from its original version to a single search for images, because the current prototype does not yet support all of the features mentioned in the task, and discovery of educational materials was determined to be a crucial feature)

Create two scenarios: one for the case where the user performs the simple search and the second where he chooses to do a categorical search.

The following table is a list of actions to achieve this task, based on prototype design:

H.2 Scenario 1: User Performs simple search

<table>
<thead>
<tr>
<th>Action</th>
<th>Screenshot name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. At the search text box, the user types in “Mars”, clicks the go button</td>
<td>Home.gif</td>
</tr>
<tr>
<td>2. User clicks on that link for the #1 results: photographs of the Sojourner.</td>
<td>Results1.gif</td>
</tr>
<tr>
<td>3. User gets more information about the photos. Clicks on the URL hyperlink.</td>
<td>Results2.gif</td>
</tr>
<tr>
<td>4. User downloads the photos</td>
<td>Not shown: sojourner photos web site.</td>
</tr>
</tbody>
</table>

In the walkthrough, I will be evaluating the interface by asking the following questions:
1. Match to intent: will users be trying to produce whatever effect the action has?
2. Visibility: will users see the control (button, switch) for the action?
3. Labeling: Once users find the control, will they recognize that it produces the effect they want?
4. Feedback: After the action is taken, will users understand the feedback they get, so they can go on to the next action with confidence?

Step 1: Users are accustomed to a search box, so this step is obvious. The labeling could be better – it is unnecessary to say “simple” – this is obvious. It may not be clear if this is searching the entire GDL web site, or the library holdings. This needs to be clearer. Maybe label could be “search our holdings” or “search for resources”.

Step 2: Labeling on the simple search button should now probably say “new search” to give (extra) feedback that a search has been processed. Here I see a problem with match to intent. If the URL is hyperlinked, it is not clear to the user which button to click! I recommend giving the user only one choice – I guess by not allowing them at this point to see the URL, because we have this intermediate page. Either that, or show all the relevant metadata up front on the results page (i.e. merge results pages 1 and 2). This seems very difficult in this case, given that we have a lot of information on these photos. This would be do-able if there were some rollover mechanism for each result, which updates the bottom half of the page rather than forcing them to click something to make it show up. Visibility issue: The user has to scan to see the word photograph, it occurs in irregular places in the description. Since this is what the user has in mind, it makes sense to have the “type” an explicit field in the results table, and the single word “photograph” or “photograph in JPEG format” show up. I think the description is useful.

Step 3: Same match to intent problem from Step 2: where does the user click now? The user wants to view the images, and download them. So there should be a button somewhere that says, “View images” or “download images”, whatever is appropriate.
H.3 Scenario 2: User Performs Categorical search

<table>
<thead>
<tr>
<th>Action</th>
<th>Screenshot name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The user clicks on the “categorical search/browse” button</td>
<td>Home.gif</td>
</tr>
<tr>
<td>2. User clicks on “choose a subject”</td>
<td>Search1.gif</td>
</tr>
<tr>
<td>3. User selects a subject (which one?)</td>
<td>Search2.gif</td>
</tr>
<tr>
<td>4. User adjusts the level of difficulty</td>
<td>Search3.gif</td>
</tr>
<tr>
<td>5. User makes spatial adjustments</td>
<td>Search4.gif</td>
</tr>
<tr>
<td>6. User clicks on radio button for #2, keywords and types Mars, Sojourner</td>
<td>Search5.gif</td>
</tr>
<tr>
<td>7. User adjusts time</td>
<td>Search5.gif</td>
</tr>
<tr>
<td>8. User adjusts level of review</td>
<td>Search6.gif</td>
</tr>
<tr>
<td>9. User selects the type of resource</td>
<td>Search7.gif</td>
</tr>
<tr>
<td>10. User selects file format</td>
<td>Search8.gif</td>
</tr>
<tr>
<td>11. User selects source of info</td>
<td>Search9.gif</td>
</tr>
<tr>
<td>12. User selects educational standards, chooses “college level basic”</td>
<td>Search10.gif</td>
</tr>
</tbody>
</table>

Summary of Walk-through for the categorical search

1. Labeling: Categorical is, to me, non-standard terminology. I prefer “refined” or “detailed” search.

2. The rest of these steps need some explanation. There is not a clear match to intent here, the user may not realize that she needs to click on each radio button sequentially, and fill in information. An instruction box should appear somewhere, explaining to select the search fields she wants to specify, and fill them out, and then when ready to search click on “begin searching.” There should also be a help button available here, that is present throughout the process in case the user gets caught up!

3. Visibility: There should be explicit instructions on how to multiple select, since most people (I’m guessing) do not know how to do it. Right above or below the “choose a subject” there could be the instructions, hold down command or shift or whatever for multiple select.

Other things quickly: the labeling above the menu bar should change, depending on what they are selecting.

The Labeling of “Educational standards” is not clear – maybe educational level and standards or something, to indicate they can also set the level there.

Why are there two places to adjust educational level? It should be the slider or the selector, not both. The slider should not appear in the “Adjust your search,” to change difficulty of material or level of review, because those things seem different – should be in a separate section!