# A User-Centered Content Architecture for an
# Academic Digital Research Portal

Erika Rogers

Mary M. Somerville

Alissa Randles

As part of the digital evolution of libraries, librarians are now expected to serve in new roles as knowledge mediators, and to provide much more technologically based support and assistance for students' progress towards information literacy. This paper describes an ongoing collaborative project between students and library personnel to incorporate usability evaluation, interaction design techniques, and instructional design theories in the design and development of a flexible web-based Research Portal.

With the rapidly increasing incorporation of technology in academic environments, many feel that the role of libraries will change dramatically from passive resource centers to active centers of instruction, exploration and learning. As part of that evolution, the roles of library personnel will also change from artifact archivists and retrieval experts to intermediaries who can help turn the massive amounts of accessible information into meaningful knowledge (Race 2004). However, this means that providing access to digital resources is only the beginning of the services expected – more and faster information is already on its way through network advances such as Internet2, and yet many libraries are still struggling just to keep up with the design and development of basic web access capabilities. Although there are commercial products available that support some of these needs, it is rare that they can be implemented straight "off the shelf". Customization and adaptation of these fundamental products can often tie up limited IT resources, as libraries and their personnel work to stay current with the ever-changing nature of technological competence. Internally developed electronic resources such as specialized subject websites must not only support these changes, but must anticipate future new trends. Otherwise, by the time the "old models" are implemented, they are already out of date. However, before implementing contemporary web interface designs that require increasingly more advanced technical skills, librarians must work to cognitively reframe their expertise into Internet-accessible "chunks" in order to provide appropriate content for the new wave of information literacy support.

In this paper we look at the particular role of Subject Specialists in our library, and describe the use of usability and interaction design techniques to affect a paradigm shift in the design and development of the supporting Subject Specialist websites. In the initial phase of this project, we made a transition from individual, personalized Subject Specialist web pages to a common "one size fits all" format, which captured much of the relevant content for each subject and each Subject Specialist. This "one-dimensional" model of content architecture placed all of the content within a single navigation and presentation framework, and expected all of the Subject Specialists to more or less conform to the same model. Our subsequent usability study, however, moved our thinking to a two-dimensional meta-design that supports different categories of students in a flexible, adaptive manner. On the one hand, the content is organized along a temporal/curriculum-based dimension, addressing the needs of students in terms of their different levels of academic progress. On the other hand, the content presentation also addresses two different aggregate learning styles dimensions. Implementation of such an adaptive Research Portal should allow us to

facilitate students' information and technology literacy in a more effective and customized manner, thus addressing the issue that "students are not a monolithic population across any dimension of behavior, including IT usage" (Kvavik 2004).

## Phase I - The Development of a Common Template for a Subject Specialist Website

This project began in January 2004 when students in a senior-level computer science course in Human-Computer Interaction undertook to help the Cal Poly library develop a design for their Subject Specialist web pages. (Subject Specialists are faculty librarians who specialize in locating and using research resources in a particular subject). The students conducted surveys of both faculty and students and led a focus group session with the Subject Specialists. Their results showed that the overwhelming majority of both faculty and students studied did not know what a Subject Specialist did or where to find one. When asked where students go to do research, seventy-two percent replied that they use the Internet while only four percent said they went to the library. The study found that most students use the library website as a tool to find books and journals, but they know nothing about library personnel, such as Subject Specialists, whose job it is to help students find books, journals and other relevant resources. This is in keeping with Seamans' findings that "students often do not see libraries and library personnel as part of their information-support network", relying instead upon the Internet and their friends for assistance (Seamans, 2002).

While a few of the eight Subject Specialists had some kind of web-based material dedicated to helping students, and one had a very well developed set of course materials, most of the topics for the majors were not in web-accessible format. This meant that the original content had to be collected and organized. The students worked with the Subject Specialists to create a template for a website that would have information on books and journals and other key information resources for academic majors. After polling students and faculty, they found that both groups wanted students to have access to class project help and a listing of the databases associated with their major. Based on these results, a prototype template was produced by the students as shown in (Fig. 1).

## Phase II – Focus on One-Dimensional Content Development

Two students continued the work in the spring quarter as their senior project. However, librarians now specified that they did not want the students to design actual web pages, but rather to focus on the creation of a content architecture and suggestions for possible mappings from the content architecture to the web page components. This restriction actually helped the project because it put the focus on the information and not on stylistic issues such as font sizes and page layout decisions. (The latter were found to be distractions when discussing project issues with the Subject Specialists.)

The Subject Specialists were directed to begin producing content information while the student researchers looked at ways to embed information literacy into the basic organization. Three different types of information documents were produced by the Subject Specialists: basic research, basic research with a narrative, and assignment driven research. The first type of document lacked any descriptive text and just listed books and journals to search with no mention of why these resources were listed. This information was deemed to be useful mainly to students who were already familiar with a particular subject area. The "basic research with narrative" document included a narrative explaining why the resources were listed and provided general research tips for students to continue their research after leaving the website. These first two types of documents covered the needs of general senior project help and searching the library databases, but they did not include information to assist students with their specific course needs. The third type of document produced was already posted on the Internet as a web page. One Subject Specialist had taken questions students presented at the library's reference desk and 'answered' them online in the form of course information pages. After responding to specific questions, the Subject Specialist went on to provide more information that might be relevant to various assignments related to those courses (Somerville & Vuotto, 2005).

We combined this initial work with a review of some library web pages from Monash University in Australia (Monash 2004), which contained an excellent model for subject decomposition. We also explored some ideas for the application of Bloom's Taxonomy of Learning as a basis for the outline of the content (Bloom 1964). Since each
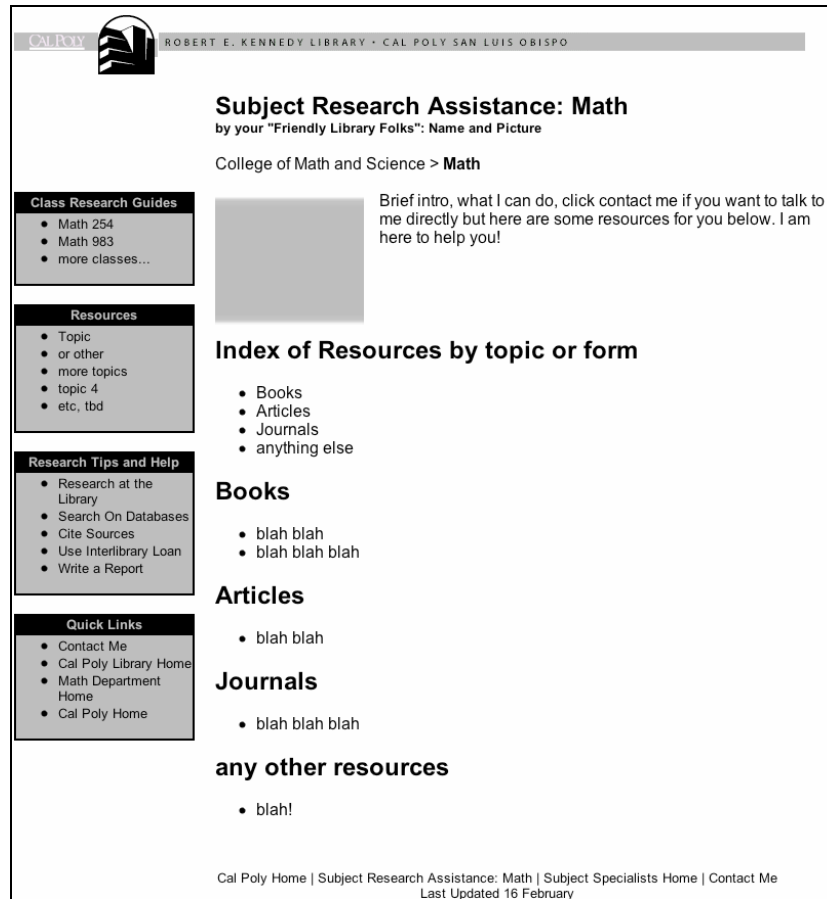
**Figure 1 - Example of Initial Template for Subject Specialist Page**

student approaches research from a different skill level, it was thought that describing each resource using a keyword from one or more of Bloom's levels (knowledge, comprehension, application, analysis, synthesis, and evaluation) might help a student categorize and narrow their search. The resources could then be organized in a manner that would encourage comparisons between multiple sources to help attain the "evaluation level" of Bloom's theory.   The combination of these ideas resulted in a more extensive framework that was presented to the subject specialists both in a graphical format as well as a textual template that they could fill in with content appropriate to the subject area.  Over the summer, several prototype subject pages based on the students' recommendations were developed by the library web team. Although they lacked consistency and not all were completed, we felt that there was sufficient basis for studying what the students liked and disliked, making more room for their input in the continued development of these pages.  An example of one of these websites can be found at (Gamble 2004).

## Phase III - Usability Evaluation and Transition to Two-Dimensional Thinking

In fall of 2004, a usability study was designed and conducted with a view to obtaining student feedback on the most recent Subject Specialist web pages.  Our original intention was just to gain basic usability data to assist the library staff in finalizing the pages, and perhaps making some improvements in navigation and layout.  However, we designed the study in the form of a questionnaire that focused on four key ideas: student research habits, student research skills, student learning styles and a usability study of the current web pages. We planned to explore several new ideas in the course of this study:  the potential effects of learning styles (Fleming 2001), whether the concept of "scaffolding" could be effectively incorporated into the website re-design (Kolar 2002), and the use of  "personas" as an interaction design technique to model archetypal end-users (Cooper 2003).  The results of this work suggested

that we reconsider the whole approach to the website design, and thus we developed a two-dimensional meta-architecture that we now framed as a Research Portal rather than a long list of individual web pages.

A total of twenty-three participants were recruited to take part in the study—twenty-two from Cal Poly and one from Monash University in Australia. Students at Cal Poly were randomly approached volunteers found in the library reserve room and the university student union. Most were taking a break between classes or studying on campus, and were willing to take a ten to fifteen minute survey that included a learning styles component (Fleming 2001). They were given the two-page questionnaire and a wireless laptop with a homepage open in Internet Explorer with links to the study web sites. After participants completed the questionnaire they were able to ask questions or give comments, and were then given a summary of their learning styles and some study tips for those learning styles. Of the twenty-three students that completed the questionnaire, eleven were from the College of Engineering, five were from each of the College of Liberal Arts and the College of Science and Math, and the remaining two represented the College of Business and the College of Architecture. (Only the College of Agriculture was unrepresented.) They ranged in experience from first year to master's level, and conducted research primarily for course assignments (70%) and papers (61%). Only thirty-five percent said they did research for personal enrichment.

Key findings from this study that impacted our design included the following:
**Resource Usage** - There was a pattern of resource usage across and within the colleges that showed that the younger students used a wider variety of resources, the "middle" students used less of a variety, and the later year students again used a wider variety. This finding led us to consider a temporal/curricular aspect to the website design. The students that had an easier time of finding or using resources each had certain "preferred" resources, and did not have much of a range of resources that they used. These students also had more multimodal learning styles.
**Learning Styles** - Over half of our participants showed a strong kinesthetic learning style. This was in keeping with Fleming's observation that in a comparison between faculty and student learning styles, students leaned significantly more toward the kinesthetic (Fleming 2001). More generally, this may also be connected to the portrayal of the current generation of students as "preferring discovery-based learning" and "emphasis[ing] action and experimentation by trying things themselves" (Kvavik 2004). (Cal Poly also advertises itself as a "learn by doing" institution.) This suggested that perhaps the learning styles component should be considered more seriously in our design plan. Virtually all of the participants exhibited strong learning style preferences (a score of more than 5 in a category), and almost half were multimodal. Both of these findings were used to reinforce the idea of using learning styles in the design – strong preferences might indicate that students may be more dependent on the presentation style of the material for ease of learning, and multimodal styles also support the idea of having more than one presentation modality.
**Website Usability** – Students suggested dividing the subject pages into an advanced view and a general view or a major/non-major view. There were also comments about the long length and organization of the page, as the text was extensive. This made it intimidating to read and difficult to locate the most useful information. This is also in keeping with other researchers' findings that students have a difficult time navigating through the "vast amounts of information [like the extensive variety in choices of cereals]" available (Seamans 2002). Students wanted more graphics, and a more personal touch from the Subject Specialists, including more personality and more evident depictions of who they are and what they do. Other usability features suggested were: specific books used in a particular course, information on senior projects (how to research a senior project, who can help students, senior project ideas), a list of key and leading journals (highlighting the top few), links to other related Subject Pages, librarian contact information, link to the 24-hour librarian service, links to outside research organizations, industry contacts, a clarification of which databases have full text vs. abstracts only, and examples of professional projects related to different majors.

Students were extremely curious about the availability of Subject Specialists and their web pages after the study was conducted. There were suggestions of integrating these web resources with the Cal Poly Portal, career services, the University Union and the college advising centers. Many wanted their availability publicized in their classes, and recommended that contact information be made easily accessible from the main library web page.


## User-Centered Content Architecture Design

Throughout our design process, we were interested in providing "levels" of support that reflected certain instructional design theories such as Bloom's Taxonomy and scaffolding. The latter theory suggests that there is

gap between the learner's actual knowledge and development and the learner's potential level of knowledge and development. Scaffolding helps to bridge the gap between what the student currently knows and what the student can know by providing challenges that are just beyond what the student can do alone. The support given is not too easy so that it is boring, and not too challenging so that the student is discouraged (e.g., Riddle 1999). We were very attracted to this idea of scaffolding with its strong pedagogical basis. However, we also realized that our new library Research Portal, while being adaptive to different levels of students, should not be designed to explicitly challenge students in the same manner as their academic curriculum. By using the Research Portal in different levels of support, students should certainly gain explicit and implicit levels of information literacy. However, the goal is to support their studies – class assignments, projects, reports and senior research, not to make the site another hurdle through which to struggle. Therefore, we decided to incorporate different levels of information access and learning opportunities appropriate to the varying levels of sophistication. However, all levels should be accessible at all times, so that students can go back to review previous information, or look at the information from a different perspective, without feeling that they're being tested.

We then used the results of our data analysis, together with information about the Cal Poly curriculum, to propose an initial set of six "personas" that represented a range of student capabilities. The development of personas is a method for modeling users, which considers their goals and the motives for these goals. They are composite user archetypes based on data gathered from actual users (Cooper, 2003). In our case, the goals and motivations of these personas reflect the two dimensions of the content architecture: the temporal/curricular dimension of content organization shown in the three levels of academic progress and expertise as well as the learning styles dimension of content presentation shown in (Tab.1).

|  | Younger/ Lower Years | Middle/ Intermediate Years | Older/ Advanced Years |
|---|---|---|---|
| **Visual and Kinesthetic** | More breadth, research skills and strategies emphasized with a visual and kinesthetic design for the page: more graphics, videos, demonstrations of experiments, examples and samples; organize information into graphs or diagrams | Major and support course assignment pages with a more visual and kinesthetic design for the page. | More depth of the topics for more intensive research with a visual and kinesthetic design for the page. |
| **Auditory and Read/Write** | More breadth, research skills and strategies emphasized with an auditory and read/write design for the page including: organize diagrams or graphs into statements, auditory links on web site, interactive video/chat feed to talk to a Subject Specialist | Major and support course assignment pages with a more auditory and read/write design for the page. | More depth of the topics for more intensive research with an auditory and read/write design for the page. |

**Table 1: Content Presentation Based on Learning Styles**

The three temporal levels (based on the student's year/level in school) build on each other, as the research skills developed early on can be applied in their later research. The assumption is that, although they can always look up something again, they will have developed the skills necessary for finding the information they need and can usually proceed from there. The goal is for students to build a solid foundation earlier on, understanding the resources available and becoming proficient with their use —so that in later studies they can conduct research with confidence, focusing instead on higher level 'sense making' activities. Finally, at all levels, the Subject Specialists are available as a resource to the students, either electronically through email, virtually through video-conferencing, or personally through library office hours.

## Current Status – From Theory to Reality

Work with the library's Subject Specialists (now known as Knowledge Managers) continues. Currently, we are co-designing a Research Portal that provides students with a customized gateway into the world of information and research competency. In mapping the pieces from the current subject specialist pages into the new two-dimensional model, we realized that we didn't really need to create completely separate pages reflecting the different learning styles. In fact, we could present a single page that contained the basic text content and annotate the various sections with available audio, video, and graphic materials. This will allow all students to have the choice of viewing

information appropriate to their learning style(s) without forcing them to visit completely different pages with redundant information. The second key insight was that the temporal approach to student views (i.e., freshmen, middle years, seniors) is not the best way to organize the research content. In fact, a better approach is to consider the students' information competency levels, and to present the information according to whether the students are beginners in information competency, more experienced, or advanced. While these categories may actually correspond to the academic standing of most of the students, the emphasis on students' knowledge, skills and abilities to find and use relevant research resources allows us to more effectively categorize the content. We also plan to embed information competency tutorials and self-tests throughout the Portal, to encourage students to appreciate their progress through monitoring their own learning. We expect to have much of the content for the Research Portal architecture completed this summer, and plan at that time, once again, to institute a set of usability studies to test the effectiveness of our design. The iterative process of user-centered interaction design, with its emphasis on inclusion of the various stakeholders in the design activity, has helped us to develop a promising new approach to our digital research services. We expect that these new ideas will provide a strong basis for establishing a flexible and forward-thinking Research Portal that will better serve our students in their goals of academic success and life-long learning habits.

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