PROCEEDINGS OF THE CONTRIBUTED PAPERS SESSION
Biomedical and Life Sciences Division

Special Libraries Association

93rd Annual Conference
Los Angeles, California
June 12, 2002

Optimal Information Foraging and Key Resources for Undergraduate Biology Students

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Abstract

Every year universities enroll students who are not only computer reliant and technically savvy but also increasingly expect digital resources and services 24/7. At the same time finding high quality and course appropriate information amongst the vast array and diversity of tools presents a practical challenge for students and a pedagogical one for librarians. In response the Gerstein Science Information Centre of the University of Toronto is in the process of creating a "Desktop Library" aimed at first year biology students.

The guide is being developed in conjunction with a specific course, BIO 150, but ongoing use through a progression of undergraduate courses is envisioned. Faculty, undergraduate and graduate students are included in the development process via focus groups, usability testing and other methods of soliciting feedback. A gradual rollout is planned. This online tool will consist of two interrelated components.

The first component will create a "Desktop Biology Library" of core journals, monographs, guides, and other starting points with an emphasis on digital information. "My Library" technology is being used so that resource lists will be further customisable by users.

The second component is the creation of an "Optimal Information Foraging" web based tutorial linked to the "Desktop Biology Library". The main teaching objective is to demonstrate through example and interactive exploration, successful searching and evaluation information strategies. BIO 150 has several existing modules, which have proven very successful as learning vehicles. Biological terminology will be used to facilitate relevance and interest, hence the title ""Optimal

Information Foraging"."

This paper will describe project planning, content and implementation. Lessons learned for library instruction, digital library technology and collaborations will also be discussed.

Introduction

The current generation of university students' computer literacy is matched by its expectation that information, resources and services will be available digitally, remotely and 24 hours a day. In response, many academic libraries including the University of Toronto (U of T), have aggressively acquired electronic resources. However, the very richness of resources challenges students, librarians and faculty alike. Computer skills cannot be equated with academic research skills, and so undergraduates, in particular, require training and guidance to identify assignment relevant information. Faculty note a proliferation of undergraduate research papers that cite only dubious quality web sites and demonstrate an abject lack of knowledge about scholarly information. Meanwhile, librarians face pedagogical and logistical challenges when trying to impart information literacy skills. Lakos (2001) notes "libraries and universities have to make access to information seamless, relevant and personally useful to clients and stakeholders while at the same time competing with new information providers." Mazoué (1999) postulates that access to a well-structured information rich database is key to delivering effective online instruction. Thus the mere provision of information and instruction is far from sufficient. Content, instruction and delivery must be practically and conceptually linked.

In response, the Gerstein Science Information Centre of the University of Toronto is creating a portal called "My Biology Library" and an online "Optimal Information Foraging" tutorial to target first year biology students. These two inter-twined components will provide selected resources and instruction on how to efficiently search for, find and evaluate scholarly information. A specific introductory course (BIO 150) was chosen due to a combination of factors: interest from the course co-ordinator; large class size; existing interactive online course components; course assignment requirements; and the potential for further use and adaptation by other higher level life science courses.

"My Biology Library", developed using "My Library" software, consists of a highly selective and annotated collection of predominantly online resources such as journals, periodical indexes, e-books and websites. The creation of this desktop library tool involved the participation of a small group of biology students, faculty and teaching assistants who represented its target audience. The emphasis was on selective resources since Pace (2001) and Ketchell (2000) remind us that users desire "personal recommendations" in order to cope with information glut. Ketchell (2000) asserts that as web users become more sophisticated, they migrate towards vertical sites, or "vortals", that address their interests, and away from general mega sites such as Yahoo. As a result My Library is promoted for individual use. Currently, My Library implementations have been adopted mainly for library instruction and course support (Leamon, 2001; Ketchell, 2000; Ghaphery and Ream, 2000). Therefore, My Library technology can be described as one way of integrating resources into the workflow of the learner, researcher and instructor.

The "Optimal Information Foraging" tutorial addresses skills required to effectively use resources delineated in the "My Biology Library". We chose a web-based tutorial for several reasons. First and foremost, the large class size renders traditional library or classroom based instruction undesirable and logistically difficult. Students can learn at their own pace, time or place and refer back to sections as needed. This is an important factor as usage is envisioned to continue through a progression of life science courses. Furthermore, the medium complements the overall

instructional delivery of the course since BIO 150 has several very popular online curriculum components and exercises. In order to incorporate active learning, quizzes and interactive game features from the open-source Texas Information Literacy Tutorial (TILT) (Fowler and Dupuis, 2000) will be integrated. Active learning opportunities provide students with the ability to review and test knowledge gained.

Setting

The University

The University of Toronto is a large public and research intensive university. Of the approximately 2200 full time faculty employed, 800 are in the life sciences. The university consists of three campuses. The main downtown St. George campus serves 15,000 full time undergraduates while another 5,800 attend part time. There are almost 2,600 graduate students in the life sciences out of a total graduate population of 9,800. The vast majority of students live off campus.

The Library

The library is ranked third in North America by the Association of Research Libraries (University Of Toronto, 2001). The library subscribes to over 13,000 e-journals, 400 databases and almost 7,000 e-books. In total, the library holds over 15 million bookforms and 53,000 journal subscriptions across its 40 libraries. The Gerstein Science Information Centre serves the university's health science and science communities with holdings of approximately half a million bookforms and 5,000 current periodical subscriptions. In 1999-2000, 954,000 items were used in Gerstein out of a system total of 5,196,000. Gerstein has 43 full time staff of which five are reference librarians.

The Course

BIO 150, "Organisms in their Environment", is an "introduction to the diversity of life, how and why it arose, and the interactions of organisms with each other and the environment." Since it is a prerequisite for additional undergraduate life science courses, class sizes are approximately 1500 for the academic year and 300 for the summer term. A team of 6 instructors and 35 teaching assistants (TAs) deliver the course. The course uses lectures, labs and lecture tutorials. "Lecture tutorials" are weekly question and answer sessions with faculty. Heavy use of instructional technology is employed including web-based exercises and documentation, online test results and bulletin boards. As with many large courses, the required text is a course pack of book chapters, lecture notes and journal articles.

BIO 150 received the U of T's prestigious Northrop Frye Award in 1999 in recognition of the course's "distinguished achievements in linking teaching and research." The link begins with course faculty who are among the most active researchers and teachers at U of T. Several professors have international reputations and have received major awards for research and teaching. They lecture within their areas of expertise and present material that is at the forefront of knowledge. Lectures, significantly enhanced by digital projections, effectively incorporate text, images and animation in a manner that presents biology as a living science.

Student achievement and critical thinking skills are encouraged. Funds from the Northrop Frye Award were used to endow a Summer Research Experience Scholarship. This program enables an outstanding student to gain practical experience in the disciplines of evolution, ecology or behaviour. Small cash awards are also given to the top ranked students. Lab sessions encourage students to think as researchers, make observations, ask questions and design experiments to test hypotheses. An effective TA training program which links teaching pedagogy with practical hands-

on skills results in a 93% approval rating of TAs by students.

Project Rationale

This project marries an identified need and an exceptional opportunity. The course coordinator perceived a lack of critical analysis and knowledge in student use and evaluation of information sources. Students required assistance not only in navigating the vast array of resources, but also in distinguishing quality scholarly material. The course coordinator approached the Gerstein librarians for assistance. The initial discussion, and dilemma, provided the rationale for intertwining resources and instruction. Working with the BIO 150 community allowed not only library instruction to reach a large number of students in the life sciences, but also a unique opportunity to collaborate with a large number of influential faculty and TAs who in turn can disseminate information about library resources to other constituents. Thus, the unique audience is a key marketing tool.

We assumed that our primary audience would be mostly students without prior library instruction but with good computer skills. We decided that the main focus of the tutorial, or its "hook" would be how much time the user would save by learning how to efficiently look for quality information. The overall tone reinforces the goal of time saving. This overarching goal echoes that of the U of T and other My Library implementations (Ghaphery and Ream, 2000; Ketchell, 2000). More specific objectives are similar to other online tutorials (Fowler and Dupuis, 2000; Orians and Sabol, 1999; Sabol, 1998; Bender and Rosen, 1998):

- differentiating between the web, periodical indexes, and online catalogues;
- finding journal articles using an index;
- identifying primary research;
- deciphering a citation and determining if the journal is available in the library;
- using the catalogue;
- citing; and above all
- evaluating information

The turorial's three independent instructional modules focus on the web, journals, and monographs. The tutorial will have the same structure, look and feel as the existing course integrated online exercises and will use a biology example, hence the name "Optimal Information Foraging." It will be a pre-requisite exercise for a major research assignment. For most students, this assignment will be the first time they will have to present, orally and in writing, scholarly material and arguments. As Dewald (1999) states "students are most receptive to library instruction when they can see its immediate benefit to their course work or to an assignment that they face."

Methods and Materials

The project was greatly facilitated by the careful use of seed funding, internal expertise and published studies. The core working group was comprised of two librarians from Gerstein as well as the course co-ordinator. A modest grant from a provostial Information Technology Courseware Development Fund allowed the hiring of the web site designers involved in the existing BIO 150 online exercises. The web designers are former course TAs and share a subject background. A graduate student was also hired for discovery and inputting of resources into the "My Biology Library" and content revision of the tutorial. All members of the team have a biology background with the exception of one librarian. We reviewed existing online instruction modules (Library Instruction Round Table, 2001) and consulted the literature with regards to their creation. A key message was how easily technology can become the driving force rather than a tool to forward the

pedagogical objectives (Dewald, 1999; Simoneaux et. al., 1999).

"My Biology Library"

Like many libraries, the U of T offers the ability to create a personal portal of information resources. While Bonnett (2001) differentiates between customisation and personalization, they are often used interchangeably in the literature, as they are in this paper. My Library is a locally developed database-driven application encoded using Microsoft Access and Cold Fusion. User authentication is carried out against the library's patron database. It can be used with any browser. Capabilities include:

- Members of the U of T community can collect and organize links to web sites, online resources, library materials, and any other resources they choose.
- Links to library e-resources and the library catalogue are database-supplied and therefore dynamically updated.
- Organization and look are customizable. Users can create folders, headings, titles, and notes and modify font face, size, and colours.
- Personalized current awareness profiles allow users to receive automated alerts.

Teaching staff and librarians have the additional ability to publish research guides which are then made available on the web without password or editing options. Hence "My Biology Library" is a published guide.
During the summer of 2001, a small sample of ten undergraduates, TAs and faculty used "card sorting" to aid in the design of the optimal content and structure of "My Biology Library". Cards included variations in both nomenclature (e.g. indexes vs. databases) and content. Participants were given a stack of index cards and asked to organise said cards into a hypothetical virtual biology library. Some cards were blank, some included specific resources, while others provided synonyms for tools (e.g. databases, indexes). Respondents were asked to present their design to a librarian. Qualitative analysis was performed on both the comments and the schema to arrive at the first design iteration.

My Library software was used to create a core list of biology journals, monographs, indexes and web pages. As befits its intended audience and as a result of the wealth of resources available, an emphasis was placed on U of T licensed digital resources. Stemming from the aim of saving users' time it had to be highly selective. Selection of periodical indexes, e-books and web sites was based on adapting criteria used in the literature (Wyatt, 1997; Davis and Schmidt 1995; Courtois and Goslen, 1996; Sinn, 1998; and Sisson, 2000) and subject directories.

The journal selection was challenging in terms of both content and relinquishing control. By nature, an introductory biology course is broad and encompassing. Collaborative content selection is seen as a key factor in My Library projects (Bonnett, 2001). The librarians compiled an initial list of journals based on the top 20 journals ranked by impact factors in various biology-related subjects from Journal Citation Reports (2000), as well as by selecting relevant journals from General Science Abstracts, Biology Digest, and Biological and Agricultural Index. These indexes were chosen as those most applicable to a first year biology class. The course pack was also scanned and journals from required readings were included. Faculty assessed the list in consideration of their own needs and that of undergraduates. A preliminary list of 170 titles was compiled.

"Optimal Information Foraging" Tutorial

The "Optimal Information Foraging" tutorial is modelled on several existing online exercises created especially for the course. The exercises provided not only the basic framework for the tutorial but also a common look and feel:

- approximately one hour to complete;
- visually engaging;
- limited information per screen with supplemental information provided via links;
- interactivity provided via games and quizzes;
- unique content which is required for assignments and midterms; and
- common structure, look and feel.

Existing BIO 150 tutorials also provided an implementation schedule. Feedback is gathered in the first year to indicate needed changes. In the second year, content is formally incorporated into the curriculum and marking scheme.

Content was written by the librarians and then vetted by the graduate student assistant and course coordinator prior to being encoded into XML. The interactive features, which consist of Flash- and Java-based components, are considered integral to illustrating and enforcing the tutorial's concepts. Therefore, a text-based version was not constructed. Students of BIO 150 have access to not only computing facilities provided by the Faculty of Arts and Sciences, but also workstations within the U of T libraries. All the workstations on campus are capable of meeting the optimal technical requirements of the tutorial. The interactive features were also supplemented from the games available for downloading and modification from the open-source TILT module.

Results and Discussion

The team built upon knowledge, experience and lessons learned from two existing stand-alone tools, a web based tutorial and a "My Library" resource. A previous collaboration with faculty from the Health Policy, Management and Evaluation Department created the first My Library pilot. This early implementation led to design changes within the software, accurate estimation of timelines, and a methodology for resource selection. In addition, a web based tutorial had been created the preceding year to complement an in-class lecture and demo for a third year biology research assignment. In addition to building upon knowledge gained from resolution of technical issues and database structure, the current project subsumes the pedagogical objectives of this stand-alone tool.

The developers envisioned a tool whose use would begin in BIO 150 and continue throughout the students' career as they take second and third year biology courses. Since faculty and TAs (mostly graduate students in the life sciences) significantly influence undergraduate information seeking behaviour, we needed to create a tool that would appeal to all three user groups. A critical common denominator was the need to save time and effort. Faculty and graduate students involved in the course could use the "My Biology Library" to access their most frequently used e-journals and there would be a link to the appropriate section of the "Optimal Information Foraging" tutorial for undergraduate students who lack the knowledge and skills in finding articles from an index.

The project and approach have been time consuming. Librarians needed to acquire knowledge about the life sciences curricula. It is a decided benefit for a librarian to have a subject background in biology, particularly resource selection and suggesting appropriate examples and topics for the tutorial. In addition, knowledge of HTML coding is also advantageous in order to tailor the My Library interface to users' needs as well as modifying the TILT components to fit the tone and

structure of the tutorial. Meshing time schedules for collaboration can be time consuming and complicated. We have found that the slower periods for librarians differ from those of web designers and professors. As Pace (2001) reminds us, My Library is new (hence additional) and different work. The same may be said for web based instruction.

A contextual design and implementation process is planned (Ketchell, 2000). A variety of formative evaluation tools will be used during the design phase. Both components will be launched this summer. Feedback from the summer class will be solicited and integrated before the arrival of the much larger fall class. In addition, the course co-ordinator will compare assignment grades as well as the quality and types of resources cited before (2002) and after (2003) implementation.

"My Biology Library"

Reade (2001) notes that "…the ultimate goal of customisation, at least as interpreted in an academic setting is to make the presentation layer reflective of the users' research process". It was important to incorporate user group input from the very start to ensure that the real needs of the biological sciences community, and not the librarians' perception of these needs, would be met. Hence the card sorting focus group exercise was conducted before work proceeded on either component. The results indicated:

- participant designs were quite divergent;
- confusion centred mostly around journal indexes (purpose and nomenclature);
- disparity over the inclusion of search engines such as Google;
- strong desire for e-journals to be listed in both alphabetical and subject order; and
- most participants assumed that all items would be in electronic format.

The card sorting exercise lead to the design illustrated in Figure 1. Another small sample will be utilised to review the current content and design before the initial summer launch.

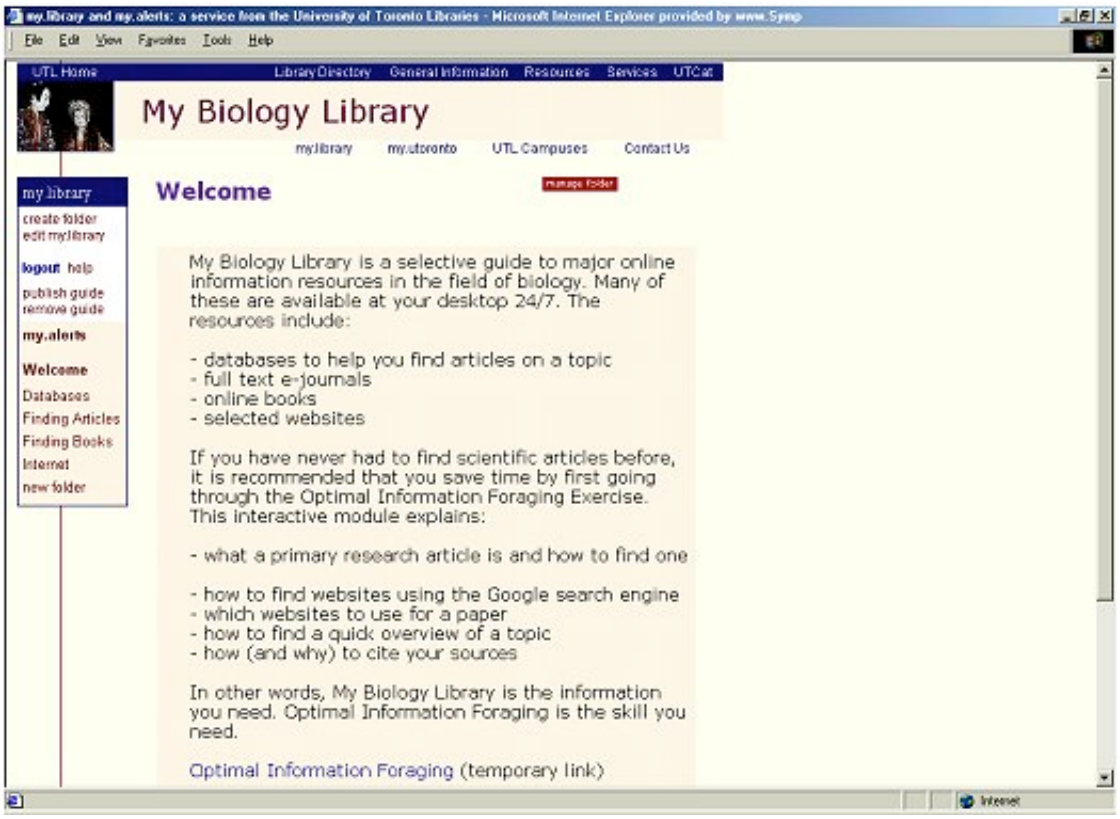

Figure 1. Opening screen of "My Biology Library"

Journal selection provided us with valuable lessons in the difficulties faced when we "take steps to cede control to our users" (Reade, 2001). Our user community mostly assumed that only electronic resources would be listed. However, Pace (2001) warns against the implicit devaluing of print resources by My Library implementations which only include electronic materials. Fortunately, only a few journals in the jointly developed core list were available only in print.

Inputting the journal section, entitled "Finding Articles", was a time consuming task. Locating, deciphering and entering holdings statements that could be easily understood by users took time and patience (see Figure 2). This value-added feature was a priority for a number of reasons:

- This was a highly requested feature from the focus group, other My Library implementations and general patron suggestions.
- We needed to include print subscriptions since most e-journals begin in the mid- 1990s thus giving a misleading and incomplete time frame.
- Many biological print journals are held in several different libraries; the holdings statements reinforce saving users' time by eliminating the need to search the catalogue.

Another value added enhancement was the addition of hypertext jumplinks at the top of every page, which enabled users to assimilate the content with a glance as well as quickly jump to the desired section without scrolling. One example is the alphabetical links at the top of Finding Articles in Figure 2 that facilitate the scanning and searching of 170 journal titles.

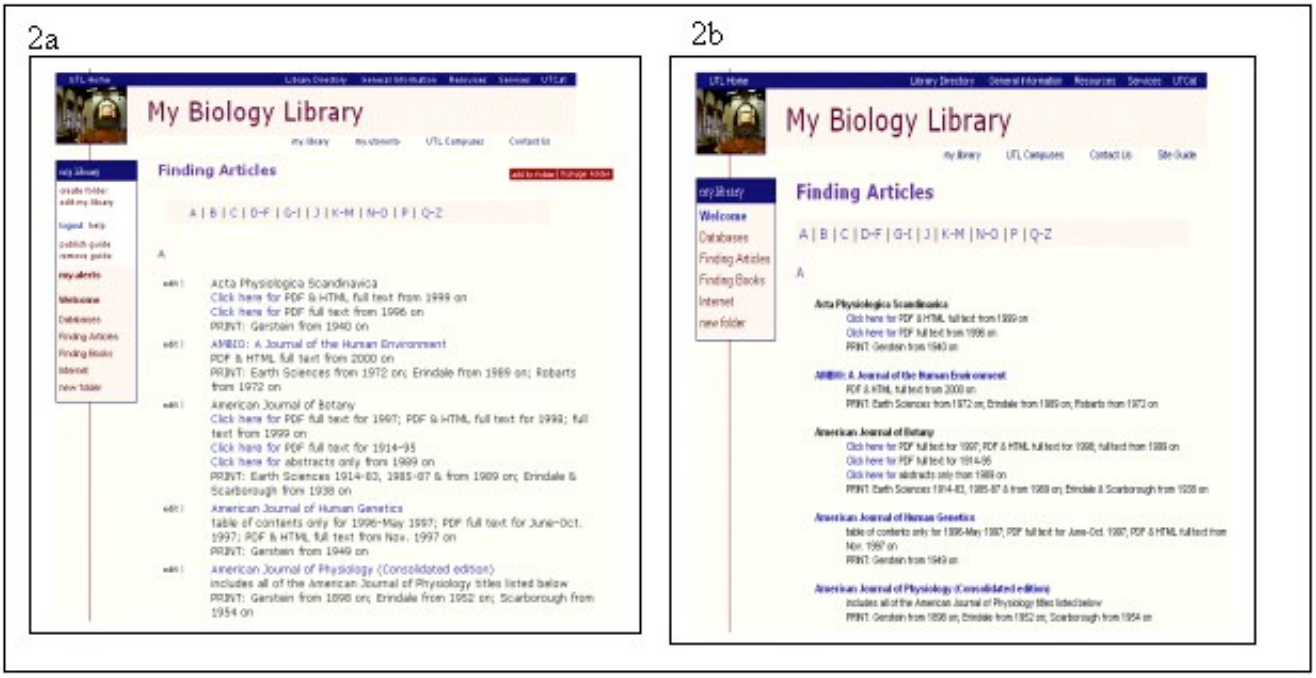

Figure 2. Finding Articles section of "My Biology Library" with holdings statements
2a. editor's screen 2b. user's screen

Future development goals for the university's My Library software include:

- integration with other campus portal projects;
- facilitation of shared information amongst individual my.libraries;
- increased connectivity with other software tools such as bibliographic management software; and

- the ability for an individual to edit a published My Library by creating a copy and further customise it for individual use.

Implementation of these goals is greatly anticipated, as this will allow members of the university community to not only further integrate information resources into their workflow but also enhance collaboration. For example, students, staff and faculty will be able to customise the "My Biology Library" into their very own personal information portals. They could create links to personal current awareness profiles, add or remove resources, or modify colours and presentation. Jasco (2001) postulates that the very success of vortals will depend on the extent of personalization.

Other developments are suggested by the literature. Currently, the project is limited by lack of web statistics. Hence we have no way of knowing which sections of the site will be most heavily used, the duration, frequency of use, etc. Collaborative filtering which "compares a user's tastes with those of other users in order to build a picture of like-minded people" is also seen as a key element to many personalised sites (Bonnet 2001). The preferences of the community are used to predict appropriate content. While Bonnett (2001) reminds us that this may be less important when categories of users and preferences are already well known and well defined, the life sciences community probably has a diversity of information preferences with varying degrees of attachment. Lastly, Ketchell (2000) envisions "next steps in personalization are likely to be interactive and require re-envisioning provision of service in a virtual environment." We can only begin to imagine how options beyond virtual reference service could be offered.

"Optimal Information Foraging" Tutorial

Navigation features and content independence allow easy transition between modules, although the linear direction of the tutorial is to first proceed to the web, followed by the journal and monograph modules respectively. We assumed that this was the natural starting point for an undergraduate versus the librarian's preference for background and overview materials found in books and encyclopaedias. Common internal navigation features that can be seen in Figure 3 include links to the web, journal, and book sections; glossary; tutorial's main page; and the BIO 150 main course page. As Dewald (1999) indicates, navigation is important not only in allowing the student some degree of choice in the order of progress but also indicating the organisation of the tutorial. Common sections, such as evaluating and citing, will be linked to from all three modules. The tutorial will also be short enough to be completed within 60 minutes, which is comparable to the duration of other BIO 150 online exercises.

Figure 3. Draft opening screen of "Optimal Information Foraging" Tutorial

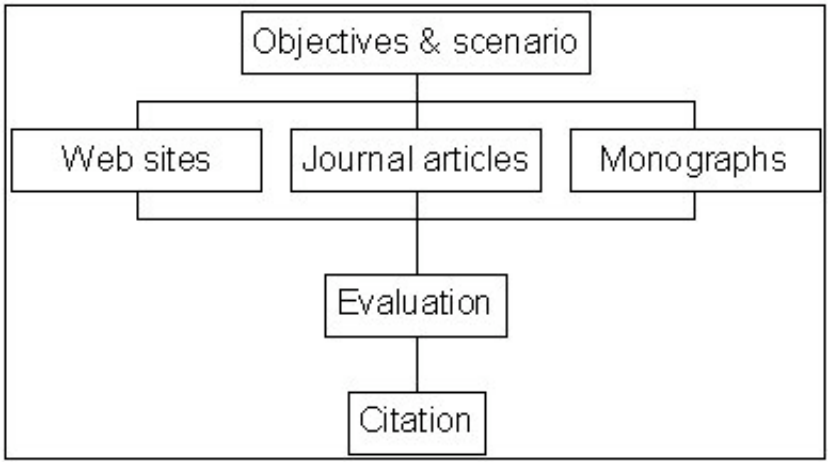

Figure 4. Flowchart of tutorial

Interactive games, quizzes and links reinforce major concepts. To maximise our limited funding we chose to adapt the Think Fast, Tiltometer, and Library Squares games from the open source TILT tutorial. Quizzes are a standard feature of BIO 150 online exercises and have been incorporated into the "Optimal Information Foraging" exercise as well. There are also links that lead to more detailed information from each section such as how search engines and paid placement work; different types of research articles; and the scholarly information and peer review cycle.

The most challenging aspect of tutorial design was to derive a storyline, or "hook" that would capture the students' interest and make it appealing. As mentioned earlier, the time saving factor was chosen. The opening screen will show a discussion between two students where one is relaying how much time was gained by employing the skills acquired from the tutorial. The second student is then compelled to try the tutorial prior to beginning the assignment since course work, a

part-time job and an active social life inundate him / her. Content was written by one of the librarians, reviewed by the student assistant, passed to the second librarian for further comments and then the fourth draft vetted by the course co-ordinator prior to being encoded into XML.

The tutorial demonstrates how to find information from three different sources within the overall framework of researching a term paper on "alien/biological invasions". Close team co-operation was needed to select a topic. Early attempts involved developing content using examples of web pages with controversial content or strong biases in order to emphasise evaluation and critical selection. However, these examples were included among assigned paper topics, and so were discarded as conveying an unfair advantage to some BIO 150 students. We also concluded that the example selection had begun to drive the tutorial instead of the pedagogical objectives. The team decided the instructional content should exist independent of the example. If we change the example in the future to utilise "hot" topics, it should not be necessary to re-construct the entire tutorial. The objectives would then be the driving force and not be overshadowed by the example. Hence in the same way that technology can overshadow pedagogy, so can searching.

We also planned to couch the tutorial in biological terminology, especially within the biological construct of optimisation and foraging as a means of engaging the students' interest. The information seeking equivalents of the three standard features of optimisation models were considered:

1. Behavioural: should you continue to search for information on the Web or instead look in books or journals?
2. Currency: ultimate goal is to get an A on the term paper; immediate goal is to find good reliable information in as short as time as possible.
3. Constraints: users are not only faced with time constraints, but also scattered resources (source types for example), diminishing returns from utilising one resource (e.g. a journal index) and learning curve.
   However, we felt that this might limit the tutorial's appeal to the broader life sciences community. In addition, we feared that biological terminology (rather than library jargon) would drive the content, not the instructional goals.

Tutorial use will be mandated by the course co-ordinator in 2003-2004. Students will be required to complete this online exercise prior to starting a research term paper and oral report. The assignment instructions call for a variety of references and not just websites. Articles from online journals with print counterparts are not considered websites.

Conclusion

Instead of building resources for a large group of undefined patrons, we are using our knowledge and collaboration with a specific course to build tools that will be generalisable to a large section of our user community. Collaboration, the key to generalisation, has been infinitely rewarding and at times infinitely challenging. This "ground up" approach requires a heavy time commitment, which we have somewhat obviated by sampling. Sampling has the added benefits of keeping users involved and checking our "information seeking" assumptions. It is also a very effective way to manage and delegate work for a large project while continuing other responsibilities.

Current delivery of library instruction often involves constant repetition of basic content in one-shot 50-minute sessions. There is usually not enough time to teach a progression of skills or concepts as opposed to mechanics. With an online tutorial to cover the information "basics," library instruction for U of T's life sciences could instead expand to higher level concepts such as more

advanced search techniques, filtering, evaluation, as well as the structure of different indexes (e.g. Ovid MEDLINE). Similarly, reference staff often explains licensed databases and their relationship to library holdings. By intertwining instruction and resources we hope not only to provide 24/7 access to the digital generation, but also save user and staff time and more importantly improve relationships.

Acknowledgements

We would like to thank Professor Corey Goldman, BIO 150 course co-ordinator, for his enthusiasm, input and time. Special thanks to Amy Greenberg, our invaluable graduate library assistant, for all her work and good ideas. Thanks also to Marc Lalonde and Sian Meikle for behind the scenes fine tuning of the My Library software.

Web Sites

Information Skills Tutorial
http://www.library.utoronto.ca/gerstein/tutorial/index.html
- created with 2000 IT Funds using JLM 349, a 3rd year biology course example
Library Research Self-Study Exercise

http://www.cquest.utoronto.ca/zoo/bio150y/labs/libry99.htm
- shows existing integration between library and BIO 150 course

Health Administration Desktop Library
http://eir.library.utoronto.ca/myutl/guides/index.cfm?guide=healthadmin
- example of a subject specific research guide created via My Library

Bio 150 course site
http://www.cquest.utoronto.ca/zoo/bio150/admin/admin.html

Bio 150 self-study exercises
http://www.cquest.utoronto.ca/zoo/bio150/labs/online.html

"My Biology Library"
http://eir.library.utoronto.ca/MyUTL/guides/index.cfm?guide=biology

"Optimal Information Foraging" Tutorial
http://www.cquest.utoronto.ca/zoo/bio150y/oif/

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