DIGITAL LIBRARIES
Curriculum Development

NSF Annual Report 2007:

Collaborative Research: Curriculum Development: Digital Libraries

Note: Virginia Tech (VT) grant: NSF IIS-0535057 and
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PI (VT): Edward A. Fox;
PI (UNC-CH): Barbara M.Wildemuth
Co-PI (UNC-CH): Jeffrey P. Pomerantz

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1.   Project Participants

1.1   People working on the project
- Project Team at VT:
  o PI: Edward A. Fox
  o GRA: Seungwon Yang
- Project Team at UNC-CH:
  o PI: Barbara M. Wildemuth
  o Co-PI: Jeffrey P. Pomerantz
  o GRA: Sanghee Oh

1.2   Other organizations involved as partners
- The JCDL 2007 workshop was co-organized with colleagues from Indiana University (Mostafa) and the University of Illinois (McDonough, Mischo).
- The proposed ECDL 2007 workshop was co-organized with a European colleague from the University Carlos III of Madrid (Méndez).

1.3   Other collaborators or contacts
- Volunteers involved in module development or evaluation (including Advisory Board members)
  o Ashwini Athavale, Indiana University
  o Christine Borgman, University of California, Los Angeles

- o Lillian (Boots) Cassel, Villanova University
  - o Michael Christel, Carnegie Mellon University
  - o Molly Dotson, Indiana University
  - o Alannah Fitzgerald, Concordia University
  - o Richard Furuta, Texas A&M University
  - o Jane Greenberg, University of North Carolina
  - o Stephanie Haas, University of North Carolina
  - o Maureen Henninger, University of Technology, Sydney, Australia
  - o Eunyee Koh, Texas A&M University
  - o Elizabeth Liddy, Syracuse University
  - o Gary Marchionini, University of North Carolina
  - o Jerome McDonough, University of Illinois, Urbana Champaign
  - o Flora McMartin, Broad-Based Knowledge
  - o Brandon Muramatsu, Utah State University
  - o Uma Murthy, Virginia Tech
  - o Lindley Shedd, Indiana University
  - o Ingeborg Solvberg, Norwegian University of Science and Technology
  - o Meredith Weiss, University of North Carolina
- Additional colleagues with whom we have consulted:
  - o Jennifer Burg, Wake Forest University
  - o John F. Moore, Virginia Tech
  - o Helen Tibbo, University of North Carolina
  - o Cal Lee, University of North Carolina
  - o Ian Witten, University of Waikato, New Zealand
  - o Marcos André Gonçalves, Universidade Federal de Minas Gerais, Brazil
- Advisory Board members
  - o See listing at http://curric.dlib.vt.edu/advisory/advisory.html.

2. Activities and Findings

2.1 Major research and education activities

Project team meetings held

The project team met together on several occasions during the past year:
December 11, 2006, at Virginia Tech; June 21, 2007, in Vancouver, BC (during
JCDL); and July 9, 2007, at UNC-CH. At least one more team meeting will be
held this fall. These project meetings are essential for closely coordinating our
other activities. They are augmented by frequent email and phone discussions.

Advisory Board meetings/activities

The full list of Advisory Board members is available at
http://curric.dlib.vt.edu/advisory/advisory.html. We convened the Advisory
Board, joined by a number of other scholars and practitioners, during the JCDL
meeting in Vancouver, June 21. That meeting focused on pilot testing our planned

procedures for the expert reviews of draft modules in the DL curriculum. The process and outcomes of that meeting are described in more detail in section 2.2.

Development of the curriculum framework

During 2006, we conducted several analyses to refine the originally-proposed framework for a curriculum in digital libraries. This year, we undertook two additional analyses supporting refinement of the framework. First was an analysis of the syllabi of computer science courses on digital libraries. This analysis, in its procedures, paralleled the earlier analysis of DL courses in information and library science ILS). The findings are reported in section 2.2. Second was an informal survey of ILS faculty members who teach DL courses to identify the types of assignments given to students and the DL application used in these assignments.

Module development

Work on developing specific modules within the curriculum framework has progressed much more rapidly this year. The template being used for each module is available at http://curric.dlib.vt.edu/DLcurric/moduleTemplate.html. Six draft modules were presented to the Advisory Board at our June meeting, and others are in development. Details of our progress in this work are provided in section 2.2.

DL textbook

The PI at Virginia Tech, Edward Fox, is preparing a textbook on DLs with Marcos André Gonçalves (Universidade Federal de Minas Gerais, Brazil). It will be based on the 5S framework (a foundational theory on DLs) in accordance with our DL module framework. Before the textbook is completed, we also plan to create a booklet about DLs and make it freely available to everyone in the DL area.

2.2   Major findings

Analysis of computer science syllabi from digital libraries courses

In an effort to identify the "state of the art" in digital library education in computer science (CS) programs, we analyzed CS courses on digital libraries and digital library-related topics. The websites of almost 300 CS graduate programs were examined to identify courses on digital libraries. Fifteen courses mentioning digital libraries in the course title or short course description were identified; of these, five focused on digital libraries. The readings assigned in those five courses were analyzed, and the results were compared to the findings from the previous analysis of readings assigned in DL courses offered by ILS schools. Arms' book on digital libraries[1] was the only book assigned in these courses; *D-Lib Magazine* and *Computers in Libraries* were the two journals that were most frequently

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[1] Arms, W. Y. (2000). *Digital Libraries*. Cambridge, MA: The MIT Press.

assigned. The results indicated that there is little consistency in the assigned readings across the five courses (similar to the findings from the analysis of ILS courses) and that the two disciplines, CS and ILS, have different perspectives on some core DL topics, e.g., services. The results of this analysis were presented at the 2007 Joint Conference on Digital Libraries, as a short paper.

Analysis of project-based digital libraries courses in ILS programs

The 2006 analysis of DL course syllabi in ILS schools found that many of these courses were project-based: the major course assignment was for the students to build a prototype DL. In an effort to gather more detail about these projects, an informal survey was conducted of ILS faculty members who teach these DL courses. This survey found that the DL application, Greenstone, was almost universally used in project-based DL courses in ILS programs. The results of this analysis appear in a paper that has been submitted for a special issue of the *International Journal on Digital Libraries*, on "Digital Libraries and Education." As a result of this finding, we have begun to consult with the team at the University of Waikato, New Zealand, that develops Greenstone.

Module development

Based on the analysis of CS syllabi, the curriculum framework was revised to its present form, with ten core topics (1-Overview, 2-Digital objects, 3-Collection development, 4-Information/knowledge organization, 5-Architecture, 6-User behavior/interactions, 7-Services, 8-Preservation, 9-Management and evaluation, and 10-DL education and research). The modules currently under development, and their status, are described in the following table.

Status of module development

ID	Title and scope	Lead developer	Status
1-b	History of digital libraries and library automation	Pomerantz	Draft completed; evaluated by Adv Bd, 6/07
5-a	Architecture overviews/models	Fox	Draft completed; evaluated by Adv Bd, 6/07
5-b	Applications	Yang	Draft completed; evaluated by Adv Bd, 6/07
5-c	Identifiers, handles, DOI, PURL	Uma Murthy (collaborator)	Draft begun
6-a	Information needs/relevance	Wildemuth	Draft completed; evaluated by Adv Bd, 6/07
6-b	Search strategy, information seeking behavior, user modeling	Oh	Draft completed; evaluated by Adv Bd, 6/07
7-a	Search engines, IR, indexing methods	Yang	Draft begun
7-b	Reference services	Pomerantz	Draft begun
9-c	Digital library evaluation, user studies	Wildemuth	Draft completed; evaluated by Adv Bd, 6/07
9-e	Legal issues	Wildemuth	Draft begun (copyright section completed)

Formative evaluation of the draft modules

The 2007 JCDL meeting in June provided us with the opportunity to move forward with our evaluation of the draft modules. First, Dr. Wildemuth was able to present our evaluation plans during the pre-conference workshop on DL education (supported by Dr. Fox's earlier talk there about the core of the field, and Dr. Pomerantz's talk on IT and DLs), and we received feedback on our evaluation plans from the workshop participants. Second, we were able to pilot test our formative evaluation procedures with our Advisory Board members and other invited scholars and practitioners during our meeting with them. Our formative evaluation procedures will be based on expert reviews of each module. At that Advisory Board meeting, the participants worked in pairs to evaluate each of the draft modules, using the evaluation protocol we developed. The protocol focuses the evaluator's attention on five areas:

- Objectives: Are the objectives appropriate for the topic?
- Body of knowledge: Does the module address all areas of the topic that need to be addressed?
- Readings: Are the readings the best and most appropriate for the topic?
- Learning activities: Are the activities appropriate for the topic?
- Logistics: Is it feasible to teach the module as it is currently constructed?

The participants in the pilot test made several suggestions for improving the process; those will be implemented. The next step in the evaluation process is to establish a wiki to manage the input from evaluators. Specific experts will be invited to evaluate each module. The module will be viewable from the wiki; a discussion page for each module will be used to coordinate the evaluators' comments on it. As the evaluators reach consensus on a particular change needed, a new version of the module will be made available via the wiki, and the discussion page will be edited to show that the requested change has been made. It is expected that a number of the draft modules will be evaluated before the end of 2007.

2.3 Opportunities for training/development provided by the project

The project team consists of two full professors (one at each institution), one assistant professor (at UNC), and two graduate research assistants (one at each institution). Each of the team members has increased their research skills and experience through this project, as well as gained insights into curriculum development in the area of digital libraries.

During 2007, the research assistants have been primarily involved in three areas: supporting the analysis of the CS courses on digital libraries; developing a digital library of the readings assigned in the ILS and CS courses on digital libraries, including classification of each item based on our curriculum framework; and developing draft modules.

The analysis of the CS courses involved the collection and analysis of data concerning CS programs and their offerings, and more detailed analysis of several specific courses. As last year's analysis of ILS courses and this year's analysis of CS courses were being undertaken, the GRAs also designed and implemented a digital library of the publications assigned in the courses. They classified each reading, based on its fit within our curriculum framework, and made the full text of the reading available in the digital library. While not available for public use (due to intellectual property protection), this DL provides strong support for our further development of additional modules in the curriculum. Each of the GRAs also drafted one of the curriculum modules: 5-b, Applications, and 6-b, Search strategy, information seeking behavior, user modeling. These are now ready for expert review.

2.4 Outreach activities

Tutorials
Dr. Fox has or will be teaching a tutorial entitled "Introduction to Teaching / Learning about Digital Libraries", as follows:
* ECDL 2006, Sept. 17, 2006, Alicante, Spain, half-day
* ECDL 2007, Sept. 16, 2007, Budapest, Hungary, full-day
* ICADL 2007, Dec. 10, 2007, Hanoi, Vietnam, half-day

Workshops
* Fox, E.A., Wildemuth, B.M., & Méndez, E., workshop organizers (2007). "Curriculum Development in Digital Libraries: An Exercise in Developing Lesson Plans," European Conference on Digital Libraries, Budapest, September 20, 2007 (scheduled workshop)
* Castelli, D., & Fox, E.A., co-organizers (2007). "First Workshop on Digital Library Fundamentals," Workshop 2 at Joint Conference on Digital Libraries, Vancouver, BC, June 23, 2007
* Mostafa, J., McDonough, J., Mischo, W., Fox, E.A., Wildemuth, B.M., & Pomerantz, J., co-organizers (2007). "Developing a Digital Libraries Education Program," Workshop 1 at Joint Conference on Digital Libraries, Vancouver, BC, June 18, 2007

Invited presentations and panels
* Fox, E.A. (2007). Enhancing computing education through LIKES, NSDL, and NDLTD. Invited presentation, Google Education Summit 2007 (part of Google Faculty Summit), Mountain View, CA, July 27, 2007.
* Wildemuth, B.M. (2007). Bringing digital libraries into view on an individual's information horizon. Keynote presentation, Libraries in the Digital Age, Dubrovnik and Mljet, Croatia, May 28-June 2, 2007.
* Pomerantz, J., & Wildemuth, B.M. (2007). Digital curation issues within the context of a curriculum for digital librarianship. DigCCurr 2007: An International Symposium on Digital Curation, Chapel Hill, NC, April 19, 2007.
* Fox, E.A. (2007). 5S Perspective. Invited presentation, 1st Workshop on Digital Library Foundations, ACM/IEEE Joint Conference on Digital Libraries, Vancouver,

June 18-23, 2007. http://fox.cs.vt.edu/talks/2007/20070623JCDLdlfWkshpFox-5S.ppt

- Fox, E.A. (2007). Quality modeling. Invited presentation, 1st Workshop on Digital Library Foundations, ACM/IEEE Joint Conference on Digital Libraries, Vancouver, June 18-23, 2007. http://fox.cs.vt.edu/talks/2007/20070623JCDLdlfWkshpFox-Quality.ppt
- Fox, E.A. (2007). Core DL curriculum. Panel presentation for the workshop, Developing a Digital Libraries Education Program, Joint Conference on Digital Libraries, Vancouver, BC, June 18-23, 2007. http://fox.cs.vt.edu/talks/2007/20070617JCDLeducWkshpFox-Core.ppt
- Pomerantz, J. (2007). Digital library education in computer science programs. Panel presentation for the workshop, Developing a Digital Libraries Education Program, Joint Conference on Digital Libraries, Vancouver, BC, June 18-23, 2007.
- Wildemuth, B.M. (2007). Evaluating specific modules in a digital library curriculum. Panel presentation for the workshop, Developing a Digital Libraries Education Program, Joint Conference on Digital Libraries, Vancouver, BC, June 18-23, 2007.
- Wildemuth, B.M. (2007). An interdisciplinary proposal for a curriculum in digital librarianship. Panel presentation, Digital Libraries: Continuing the Vision of Dr. James E. Shepard, North Carolina Central University, Durham, NC, April 27, 2007.
- Fox, E.A. (2007). Digital libraries: From proposals to projects to systems to theory to curricula. Keynote presentation, DELOS Conference on Digital Libraries, Pisa, Italy, February 13-14, 2007.
- Abbas, J., Kim, K.-S., & Wildemuth, B. M. (Organizers). (2006). Education for digital librarianship: Employers' needs and how they can be addressed. Panel presented at the American Society for Information Science and Technology, Austin, TX, November 5-9, 2006.
- Fox, E.A. (2006). Digital libraries for education: Lessons learned and promising opportunities. Invited workshop keynote, LODL 2006, Learning Object Repositories as Digital Libraries: Current Challenges, 2006 European Conference on Digital Libraries, September 22, 2006, Alicante Spain (by videoconference).

3. Publications and Products

3.1 Publications

- Yang, S., Kim, S., Murthy, U., Wildemuth, B.M., Pomerantz, J.P., Oh, S., & Fox, E.A. (2007). Digital library curriculum module evaluation and tools to enhance modules and visualize their usage. Submitted for presentation at the International Conference of Asian Digital Libraries, Hanoi, Vietnam, December 10-13, 2007.
- Gonçalves, M.A., Moreira, B.L., Fox, E.A., & Watson, L.T. (2007). What is a good digital library? - A quality model for digital libraries. *Information Processing & Management, 43*(5): 1416-1437. http://dx.doi.org/10.1016/j.ipm.2006.11.010.
- Murthy, U., Gorton, D., Torres, R., Gonçalves, M., Fox, E., & Delcambre, L. (2007). Extending the 5S digital library (DL) framework: from a minimal DL towards a DL reference model. 1st Workshop on Digital Library Foundations, ACM/IEEE Joint Conference on Digital Libraries, Vancouver, June 18-23, 2007.
- Agosti, M., Ferro, N., Gonçalves, M.A., & Moreira, B.L. (2007). Towards a reference quality model for digital libraries. 1st Workshop on Digital Library

Foundations, ACM/IEEE Joint Conference on Digital Libraries, Vancouver, June 18-23, 2007.

- Pomerantz, J., Oh, S., Wildemuth, B.M., Yang, S., & Fox, E.A. (2007). Digital library education in computer science programs (short paper). *Proceedings of the 2007 Joint Conference on Digital Libraries* (Vancouver, June 20-23, 2007), 177-178. http://doi.acm.org/10.1145/1255175.1255208.

- Ma, Y., Fox, E.A., & Gonçalves, M.A. (2007). PIM through a 5S perspective (poster). *Proceedings of the 2007 Joint Conference on Digital Libraries* (Vancouver, June 18-23, 2007), 491. http://doi.acm.org/10.1145/1255175.1255290.

- Moreira, B.L., Gonçalves, M.A., Laender, A.H.F., & Fox, E.A. (2007). 5SQual: A quality assessment tool for digital libraries (demonstration). *Proceedings of the 2007 Joint Conference on Digital Libraries* (Vancouver, June 18-23, 2007), 513. http://doi.acm.org/10.1145/1255175.1255313.

- Yang, S., Oh, S., Pomerantz, J.P., Wildemuth, B.M., & Fox, E.A. (2007). Improving education and understanding of NDLTD. Paper presented at ETD 2007: The 10th International Symposium on Electronic Theses and Dissertations, Uppsala, Sweden, June 13-16, 2007.

- Yang, S., Wildemuth, B., Pomerantz, J., Oh, S. & Fox, E. A. (2006). Core topics in digital library education. *Encyclopedia of Digital Libraries*. Accepted for publication. (http://www.sci-duet.ntu.edu.sg/yinleng/encyclo-dl/call.html)

- Yang, S., Fox, E.A., Wildemuth, B.M., Pomerantz, J., & Oh, S. (2006). Interdisciplinary curriculum development for digital library education. In *Proceedings of ICADL 2006* (Kyoto, Japan, November 2006), *Lecture Notes in Computer Science, 4312*, 61-70. http://dx.doi.org/10.1007/11931584_9.

- Moreira, B.L., Gonçalves, M.A., Laender, A.H.F., & Fox, E.A. (2006). 5SQual - A quality assessment tool for digital libraries. Proceedings of WDL 2006 (Florianopolis, SC, Brasil, October 20, 2006). 10 pages.

- Shen, R., Vemuri, N.S., Fan, W., & Fox, E.A. (2006). What is a successful digital library? *Proceedings of ECDL 2006* (Alicante, Spain, September 17-21, 2006), Research and Advanced Technology for Digital Libraries. *Lecture Notes in Computer Science, 4172*, 208-219. http://dx.doi.org/10.1007/11863878_18.

- Fox, E.A. (2006). Improving graduate education with digital libraries. Invited keynote, Inauguration of the DFG Graduiertenkollegs 1223, "Quality improvement in e-Learning by feedback processes" (Eroffnung des DFG-Graduiertenkollegs 1223 Qualitatsverbesserung im E-Learning durch ruckgekoppelte Prozesse), Darmstadt, GE, September 14, 2006.

- Fox, E.A. (2006). A 5S perspective on digital libraries for e-learning: With case studies from archaelogy, computing, and dissertations. Invited keynote, DeLFI 2006 (Die 4. e-Learning Fachtagung Informatik), Darmstadt, GE, September 14, 2006.

3.2   Website

Project website at http://curric.dlib.vt.edu/. The home page provides basic contact information. Additional pages provide updates on our module development activities; a list of, and links to, project publications; a list of our Advisory Board members; and links to press coverage of the project.

3.3   Other specific products

- The up-to-date DL module framework is available at
  http://curric.dlib.vt.edu/DLcurric_images/ModuleFramework.2007-03-30-image.JPG
- The computer science DL syllabi readings analysis data are available at
  http://curric.dlib.vt.edu/DLcurric_images/DataTablesJCDL07.pdf

4.   Contributions

4.1   Contributions to the principal disciplines of the project

This project was interdisciplinary from its inception. It is our goal that its products (the curriculum framework and modules) will bring the CS and LIS disciplines closer together in their work on digital libraries. Specifically, the final product – a high quality DL curriculum – will produce DL researchers, designers, and administrators who understand all the necessary aspects of DL systems and services, as well as their particular DL specialty areas. These researchers, designers, and administrators will come from all of the participating disciplines.

DLs incorporate various technologies such as database systems, information retrieval systems, advanced user interfaces, network systems, multimedia systems, recommender systems, etc. Our DL curriculum project will provide students in both computer science and information and library science with opportunities to understand how each of the above technologies work and how they can interact together efficiently to support DLs.

Citations to project publications/works, from CS or ILS

In addition to the contributions to computer science and information and library science described above, our work already has begun to have an impact on the scholarly output of researchers in those disciplines, as represented by the citations listed below. (Self-citations are only briefly noted.)

Pomerantz, J., Wildemuth, B. M., Fox, E., & Yang, S. (2006). Curriculum development for digital libraries. *Proceedings of the Joint Conference on Digital Libraries (Chapel Hill, NC, June 15, 2006),* 175-184.
Two self-citations, plus cited by:
- Twidale, M.B., & Nichols, D.M. (2006). Computational Sense: The Role of Technology in the Education of Digital Librarians. Working Paper: 10/2006. Dept. of Computer Science, University of Waikato.

Pomerantz, J., Oh, S., Yang, S., Fox, E.A., & Wildemuth, B.M. (2006). The core: Digital library education in library and information science programs. *D-Lib Magazine, 12*(11).
http://www.dlib.org/november06/pomerantz/11pomerantz.html.
Two self-citations, plus cited by:

– Witten, I.H., & Bainbridge, D. (2007). A retrospective look at Greenstone: Lessons from the first decade. *Proceedings of the 2007 Joint Conference on Digital Libraries,* 147-156.
– Ma, Y., O'Brien, A., & Clegg, W. (2007). Digital library education: Some international course structure comparisons. *Proceedings of the 2007 Joint Conference on Digital Libraries,* 490.
– Cunningham, S. J., Nichols, D., McKay, D., & Bainbridge, D. (2007, 25 January). An ethnographic study of institutional repository librarians: their experiences of usability. Paper presented at the 2nd International Conference on Open Repositories, San Antonio, TX.

Digital Library Curriculum Project home page (http://curric.dlib.vt.edu/).
Linked to by:
– Information Retrieval Curriculum Development project page. http://collab.dlib.vt.edu/runwiki/wiki.pl?IsRprojInfoRetCurric.

4.2 Contributions to other disciplines of science and engineering

Long term, our project will contribute to the other science and engineering disciplines through the work of graduates of DL programs in computer science and information and library science. Because those graduates will have a stronger education in DL development and administration, the DLs they create (in collaboration with scientists and engineers) will more effectively provide valuable knowledge for those scientists and engineers. Our contributions should lead to the overall improvement of research efficiency and the advancement of any discipline that relies on digital libraries.

In addition, we have provided some specific support for projects in other disciplines. Project management and curriculum development advice was provided to Gregory Louie, who is developing a project on education on biotechnology, to be conducted jointly in middle schools and community colleges in North Carolina.

In VT, a multi-disciplinary curriculum building project called, LIKES (Living In the KnowlEdge Society), has been launched by the scholars in the areas such as Business and Information Technology, Computer Science, etc. Based on the DL module framework concept, pluggable LIKES modules might be developed to enhance computing education as well as core / liberal arts education. This relates directly to a new collaborative award to VT (lead institution – NSF CCF CPATH 0722259), Villanova, U. Texas El Paso, and NC A&T.

4.3 Contributions to the development of human resources

Courses created by this project will provide an improved learning experience to graduate-level students and current DL designers and administrators, increasing the possibility of improving their job performance and growth.

4.4 Contributions to the physical, institutional, or information resources infrastructure

Just as this project is expected to develop human resources through improved education of DL professionals, it also is expected to contribute to the development of more effective DLs. As graduates of programs using our curriculum framework and/or modules enter the workforce, they will be able to design, build, and administer digital libraries more effectively.

4.5 Contributions to other aspects of public welfare

DLs can be developed for many purposes, each benefiting the public welfare. For example, a DL that holds data about a community's infrastructure and resources could provide critical information during an emergency, or to aid in recovery afterwards – thus, VT has begun work on a related project with funding expected soon (NSF SGER: DL-VT416: A Digital Library Testbed for Research Related to 4/16/2007 at Virginia Tech, PI: Edward A. Fox; Co-PIs: Weiguo Fan, Christopher North, Naren Ramakrishnan, Donald Shoemaker). It could be used to identify surplus resources that could be called up for use during a natural disaster. It could be used to upload and share data, case studies, and best and worst practices for identifying and distributing the resources needed in such emergencies. Use of a well-designed and well-managed digital library can lead to improved methods and reduced cost for handling such situations. Our curriculum development project will contribute to the public welfare by producing DL experts who can design and administer such DLs.