Can Knowledge Be Distributed?

The Dynamics of Knowledge in Interdisciplinary Alliances:

Final Report

October 9, 2003

Distributed Knowledge Research Project: G. Bowker*, J. Brown, B. C. Bruce*, N. Burbules*, C. Haythornthwaite*, A. Kanfer*, M. M. Kazmer, K. J. Lunsford, M. I. Nazarova, S. Poulakos, J. Porac*, J. Wade*, M. Won. (*co-Principal Investigators)

The goal of the *Distributed Knowledge* project (*DK*) is to investigate distributed knowledge processes among multidisciplinary teams and the roles that technology and group context play in these processes. The initial inquiry of the project was focused on the six scientific Applications Technologies teams of the National Computational Science Alliance, funded through NSF's PACI program.

The Alliance is one of two NSF-funded partnerships out of the Partnerships for Advanced Computational Infrastructure (PACI) Program, consisting of over sixty educational, government and industry partner organizations with the National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign as the leading edge site. The research was motivated by the concern that the nature of knowledge processes in groups and the goals of electronic infrastructures to support distributed knowledge processes may be in direct conflict with one another. The research question was how does embedded knowledge become mobile, with a focus on the communication infrastructure, knowledge characteristics and group context. Both qualitative research methods such as ethnography, structured interviews and qualitative document analysis, and quantitative research methods such as social network analysis, event history analysis and citation analyses have been used.

The project is a multidisciplinary, multi-level and multi-method study into how electronic technologies are used to support knowledge production and sharing in this alliance and how such technologies can be used to facilitate knowledge production in other alliances. The investigators from social science, computer science, history, business, psychology, philosophy, and information science are brought together in this project to explore the social processes that are involved in virtual collaborative work.

During Year One (10/99-10/01) we focused on refining our research questions and methods, and conducting initial investigations. In Year Two (10/00-10/01), we expanded our inquiry into distributed knowledge to include other collaborative research efforts. A biggest accomplishment of the year two was the establishment of the *Distributed Knowledge Research Collaborative* (*DKRC*) as a larger group encompassing both our project and others doing related research. The *DKRC* website <http://www.dkrc.org>,

which was developed as a part of the project, is the most comprehensive repository for our research projects, including biographies, bibliographies, project summaries, calls for papers, publications, as well as password-protected document and collaboration spaces for the *DK* group itself.

During Year Three (10/01-10/02), we completed the data collection for several research efforts, have presented and published on these efforts, have begun reflecting and reporting on our own collaborative research processes, and have laid the foundations for further research.

This final report describes project highlights reflecting the accomplishments of the project as well as its participants (awards and honors, courses developed, dissertations defended, further grants and projects undertaken, selected presentations, workshops with invitation to participate and to host), project challenges, updates of new technologies and tools used, and lists project-related publications.

Project Participants

1. People who have worked on the project

Geoffrey C. Bowker*, Joyce Brown, Bertram C. Bruce *, Nicholas Burbules*, Michael DeVaughn, Harald Fischer, Chris Hagar, Caroline Haythornthwaite*, Melanie Huston, Xueqing Jiang, Alaina Kanfer*, Michelle M. Kazmer, Sarai Lastra, Karen J. Lunsford, Tim McDonough, Muzhgan I. Nazarova, Steven Poulakos, Joseph Porac*, Rajeev Ramprakash, Jenny Robins, Douglas Steinley, Katie Vann, Terry von Thaden, James Wade*, Mihye Won (*co-Principal Investigators)

2. Partner organizations

National Computational Science Alliance, funded through NSF's PACI program. The Alliance is one of two NSF-funded partnerships out of the Partnerships for Advanced Computational Infrastructure (PACI) Program, consisting of over sixty educational, government and industry partner organizations with the National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign as the leading edge site.

Inquiry Project, University of Illinois at Urbana-Champaign

Activities and Findings

1.   Major research and education activities

A substantial amount of quantitative and qualitative data has been gathered using a variety of methodologies including ethnography, structured interviews, textual analysis, social network analysis, bibliometric analysis, discourse interviews, website analysis, and conceptual critique have been also used.

A major step has been the collaboration between those of us working with quantitative and bibliometric methods, and those of us working with more qualitative and ethnographic methods. This required establishing new methods and understandings of the collaborative processes in various teams, as well as talking regularly to build enough shared language to undertake a multi-method analysis. The ethnographic and qualitative content analyses together with a quantitative network and bibliometric assessments has proved itself to be quite efficient.

E-Learning: Our research on distributed knowledge has highlighted the importance of individual and organizational learning. Accordingly, several DK projects studied how learning takes place, and how that learning is mediated through technologies. Our studies involved several aspects of learning and distributed knowledge practices: 1) We examined how new ways of learning—by both individuals and organizations—are developing as people adopt and implement new technologies. We were studying how different models of learning (hierarchical presentations, cooperative learning, inquiry-based learning) affect how knowledge is co-constructed, and how new technologies affect these models. 2) We have assumed that learning takes place not only in educational settings, but also in research labs and professional environments. As a result, we were concentrating not just on student-teacher exchanges, but on how scientists and professionals themselves learn. These studies thus reflected our interest in how knowledge can be mobilized. 3) We were interested in networks of learners, and how individual learners are positioned within these networks, and who learns from whom in a network. For instance, we have found that embedded knowledge is typically transferred when graduate students and post-docs are exchanged among laboratories.

Co-construction of a database: Social processes in shared database construction. Our studies of distributed knowledge consider how artifacts and technologies, such as email or shared data repositories, interact with knowledge processes. Definitions of the content, use and form of such information and communication technologies play an important role in the way in which knowledge is transferred and what knowledge is transferred. Often, definitions of what knowledge is considered within the scope of a project may be instantiated into artifacts such as databases. This new DK initiative explores the processes of negotiation and definition of the form and content of a database of educational materials.

We examined the social construction of a database by a university-community research initiative of the "ECAT" group (a pseudonym). Funded by U.S. government grants, the database gathers and provides online access to original academic and applied articles in the field, commentaries on the articles, and practitioner materials. Those participating in this co-construction include university faculty, graduate students, board members, field practitioners, and professional database developers. Co-construction includes defining the scope of the database, guidelines for determining appropriate materials, procedures for acquiring materials, strategies for reviewing materials, and the design of the database system itself. This DK initiative illuminates the collaborative processes leading to the development of such shared databases, and how different interests are negotiated and

resolved in the construction of such a database. It explores the important role of social processes in the technical definition of a database. This investigation included a series of semi-structured interviews focusing on the negotiation of the database definition, and discourse interviews focusing on the development of shared meaning and use of terms in documents, discussions, and database names.

2.   *Major findings*

Recent trends in work and research have increased our dependence on distributed, interdisciplinary, collaborative teams, with tremendous resources devoted to this effort from private sector investment to large-scale government investment in infrastructures, programs, and centers. While earlier work on knowledge has suggested that the main problem is that of mobilizing knowledge, and making tacit knowledge explicit for transfer to others, a closer look at the practice of distributed, interdisciplinary inquiry tells us that collaboration is more complex than such notions suggest.

Our research on interdisciplinary knowledge processes and the collected experiences of the members of the Distributed Knowledge Research Collaborative in observing, studying, and participating in interdisciplinary work addresses this complexity, including understanding the challenges facing distributed, interdisciplinary, collaborative teams. While there is a large literature on group behavior that provides insight into how we work together, interdisciplinary teams face a number of challenges that differentiate their work from that generally addressed by the work on group processes.

Emphasizing collaboration over coordination, expert over novice learning, integrative over additive knowledge construction and interdisciplinary over mono-disciplinary approaches, changes the focus of group endeavors and thus the kinds of problems encountered. Moreover, contemporary teams are often called on to operate at a distance, and can be both geographically and temporally distributed. Thus, they must also deal with the complexities of communicating at a distance, establishing new work interaction protocols and adopting new computer media. In this paper, we present characteristics and considerations which have special import to distributed, interdisciplinary work groups. We do not consider this discussion to be exhaustive, but as identifying some key factors that present particular challenges for interdisciplinary teams. These are presented to inform and prepare those embarking on distributed, interdisciplinary work, and as a basis for future investigations. Our paper on this work briefly describes our group and the teams we have been studying, then discusses how experts work together, explores learning by expert groups, and challenges associated with acting together as expert groups within current organizational infrastructures.

3. *Opportunities for training and development provided by the project*

Courses: LIS 450 DK: Distributed Knowledge. University of Illinois, Urbana-Champaign. Graduate School of Library and Information Science. Graduate seminar, Spring 2002; to be offered again in 2004. Co-taught by Bertram Bruce and Caroline Haythornthwaite. http://alexia.lis.uiuc.edu/~haythorn/lis450dk.html

Further Grants & Projects

- G. C. Bowker. 'Access to and Sharing of Data Produced from Public Funding: OECD/CSTP Working Group'. With Peter Arzberger, San Diego Supercomputer Center. NSF. $125K

- G. C. Bowker. Biodiversity & Ecosystem Informatics - BDEI: Designing an Infrastructure for Heterogeneity of Ecosystem Data, Collaborators and Organizations. With Karen Baker, Scripps Institute for Oceanography. NSF 0131958. (2001-2002)

- G. C. Bowker & K. Vann. 'Values into Infrastructure', Societal Dimensions of Engineering, Science, and Technology Program—Ethics and Values Studies. NSF 0094632. $120K. 2001-2002.

- Bruce, B. C. . Collaboratory portion of the Center for Advanced Materials for Purification of Water with Systems—The Water CAMPWS Collaboratory. NSF $20M. 9/02-12/07

- Haythornthwaite, C. *Collaborating across Disciplinary Boundaries*. This study analyzes inter- and intra-disciplinary work patterns of researchers in a variety of science and social science teams (social network data).

- Haythornthwaite, C. & Lunsford, K. J. *Collaboration around Knowledge and Artifacts*. This study explores social processes that led to the construction of a technical artifact (interview data).

- M. M. Kazmer. *Research Collaborations: Fostering Future Work Through Successful Endings.* This study is an examination of inter-institutional research collaborators and how their experiences near the end of a shared project affect their ability and desire to pursue future collaborations at a distance among themselves and with others. Funded by Florida State University First-Year Assistant Professor grant.

- M. M. Kazmer. *Understanding Virtual Work Teams: A Hermeneutic Approach.* With Gary Burnett (FSU, School of Information Studies), and Kathy Chudoba and Michael Dickey (FSU, Department of Management Information Systems). Research ongoing.

4. Outreach activities

In order to make our studies broadly useful, we have begun to translate them into practical applications as outreach projects. For example, several DK members have opened negotiations with a textbook publisher to write a guide for students involved in distance education programs. Other DK members have initiated and supported the Inquiry Page <http://inquiry.uiuc.edu/>, a website and database designed to facilitate inquiry-based learning in whatever environment it may occur. The Inquiry Page project is composed of a diverse, evolving group of educators, learners, professionals and community members. The group has come together to create tools, develop research

opportunities, and build social and professional networks for discussing, understanding and fostering inquiry-based learning. The Inquiry Page website embodies many of the lessons the DK group has learned as we have studied scientific, collaborative inquiry. It also incorporates new software and technologies developed by other research groups (such as VIBE and VISIT, two new database interfaces). This award-winning website thus provides a framework for engaging in collaborative, multidisciplinary research and education.

In another outreach effort, the DK has played a central role in founding a new Information Systems Research Laboratory (ISRL) at the University of Illinois at Urbana-Champaign. Not only does the project help support technologies to be shared with other research and educational groups, but also several DK members have actively helped design and set up the lab space. The ISRL is experimenting with an Open Source model of how research projects might interact to the benefit of all the projects. In addition, DK researchers both attend and present at weekly ISRL functions.

Selected Presentations

Bowker, G. C. (October, 2001). *International Data Sharing in Science*, OECD/CFSTP Working Group, Paris.

Bowker, G. C. (2002, September). *Values into infrastructure,* Invitational Workshop on Public Design, Information Law Institute, New York University.

Bowker, G. C. (2002, October). *Data sharing in science,* Presentation to Directorate Heads, European Science Foundation.

Bowker, G. C. (2002, December). *Memory and money*, Interdisciplinary Program on Memory, University of Illinois at Urbana Champaign.

Bruce, B. C. (1999, December). Keynote Address: *Educational technology: Media for inquiry, communication, construction, and expression.* Republic of China Multimedia Education Language Instruction Association (ROCMELIA), Kaoshiung, Taiwan.

Bruce, B. C. (2002, April 30). *Technology and literacy: Literacy in an information age.* BETHA Education and Technology Lecture Series, Ohio State University, Columbus, OH.

Burbules, N. (2002, Autumn). *Collaboration and the standards of educational research.* Invited lecture, University of Leuven, Belgium.

Burbules, N. (2002, Autumn). *Dialogue, carnival, and third spaces.* University Council for Educational Administration.

Burbules, N. (2002, Spring). *The impact of new digital technologies on educational research* (O impacto de novas tecnologias digitais na pesquisa educacional). Invited lecture, Fourth Congress Luso-Brasiliero de Historia da Educacao, Pontificia Universidade Catolica do Rio Grande do Sul (Brazil).

Burbules, N. (2000, Autumn). *Changing contexts of educational research.* Invited lecture, Third Seminar on Research in Education (Seminaro Pesquisa em Educacao), Federal University of Rio Grande do Sul (Brazil).

Burbules, N. (2000, Autumn). *Discipline, community, and standards for educational research.* Invited lecture, University of Leuven, Belgium.

Burbules, N. (2000, Spring). *Analyzing learning and discourse in distributed and nondistributed contexts.* Respondent, American Educational Research Association.

Burbules, N. (1999, Spring). *Electronic publishing: new forms of information and knowledge.* American Educational Research Association.

Burbules, N. (1999, Spring). *Technology-based tools for learning: Visualization, collaboration, and inclusion.* Respondent, American Educational Research Association.

Hackett, E. J., Haythornthwaite, C., & Horvat, M. (forthcoming panel, 2004). *Changing research paradigms and practices in the EU and US.* American Association for the Advancement of Science, Seattle, WA.

Haythornthwaite, C. (May 2003). Invited presenter and participant, *Conceptual and Technical Aspects of Electronic Learning*, Schloss Dagstuhl International Conference and Research Center for Computer Science, Wadern, Germany. Organizers: Caroline Haythornthwaite (replacing Amy Bruckman at the conference only), Wolffried Stucky, Gottfried Vossen.

Haythornthwaite, C. (May 2003). Invited respondent for a panel on *Theories of communication and technology*, International Communication Association, San Diego, CA.

Haythornthwaite, C. (September, 2003). *Social network ties and internet connectivity effects*. Paper to be presented at the Oxford Internet Institute, Oxford, UK.

Haythornthwaite, C., & Kazmer, M. M. (October, 2003). *Distributed knowledge practices and ICT*. Paper to be presented at the Annual Meeting of the Association of Internet Researchers, Toronto, Canada.

Haythornthwaite, C. & Bowker, G.C. (February, 2003). *Multimethod inquiry into collaborative processes*. American Association for the Advancement of Science, Denver, CO.

Haythornthwaite, C. & Steinley, D. (2002). *Interdisciplinary knowledge exchanges.* Paper presented at the International Sunbelt Social Network Conference, New Orleans, LA.

Lunsford, K. J. (October, 2003). *Electronic, scientific publication and collective memory practices.* Paper to be presented at the Annual Meeting of the Association of Internet Researchers, Toronto, Canada.

Lunsford, K. J. (October, 2002). *Re-mediating academic publication, disciplinarity, and identity.* Thomas R. Watson Conference on Rhetoric and Composition, Louisville, KY.

Lunsford, K. J. (May, 2002). *Other people's words: Ethical dilemmas for digitized qualitative research.* Computers & Writing 2002, Normal, IL.

Lunsford, K. J., Bruce, B. C., Haythornthwaite, C., & Houston, M. (May, 2001). *From website to collaboratory: Authoring a workspace.* Full panel for Computers and Writing 2001, Muncie, IN.

Porac, J. F. (October, 2001). *Distributed cognition in the resolution of diagnostic categories across an interorganizational network: The case of the West Nile virus outbreak in New York City in 1999.* Annual Meeting of the Macro Organizational Behavior Society. New York University, NY.

Vann, K. (2002). *Technoecologism and the social construction of environmental stakeholder interests.* Panel on *Modeling.* Annual Meeting of the Society for the Social Studies of Science. Milwaukee, WI.

Vann, K. (2002). *Collective practices after 'practice.'* Invited contribution to the Conference on Distributed Collective Practices. San Diego, CA.

Workshops

Bruce, B. C. . (2003). Invited Participant, The *Evaluating Educational Impact Workshop* (for the National Science Digital Library), Oct 1-3, 2003

Bruce, B. C. . (2003). Invited Participant, Workshop on *Creation of an American-German Research Network in the Field of Technology-Supported Education.* University of Tübingen, Germany, Nov 12-16, 2003.

Bowker, G. C. (2002). Invited Participant, *Workshop on Collaboratories*, National Institutes of Health, September 2002.

Haythornthwaite, C. (2002-2003). Invited participant, *Ecology Transformed? A Working Group to Study New Forms of Scientific Collaboration*, funded by the National Center for Ecological Analysis and Synthesis, May 5-6, 2000, January 10-13, 2001, and March 8-10, 2002. Organizer: Ed Hackett. [work has resulted in a panel for the American Association for the Advancement of Science, Feb., 2003, title "Scientific Collaboration in Transition"]

Haythornthwaite, C. (2002). Invited participant, *NSF-KDI Workshop*, New Orleans, LA. April 26-28, 2002. Organizers: Sara Kiesler, Jonathon Cummings.

Haythornthwaite, C. (2003). Invited presenter and participant, *Conceptual and Technical Aspects of Electronic Learning*, May 5-9, 2003, Germany. Organizers: Amy Bruckman, Wolffried Stucky, Gottfried Vossen.

Haythornthwaite, C. (2003). Invited presenter and participant, NSF Workshop on the Future of Graduate Education, March 19-20, 2003. Arlington, VA. Organizers: Joan Lorden, Jennifer Slimowitz.

Haythornthwaite, C. (2003). Invited respondent, panel on *Theories of communication and technology*, International Communication Association, San Diego, CA. Organizer: Teresa Harrison.

Hosted Workshops

Bowker, G. C. (February, 2002). Co-organizer, *International Workshop on Distributed Collective Practice,* San Diego.

Distributed Knowledge Project (2001, February 1). *Distributed Knowledge Worksho*. Hosted by Bertram Bruce, Caroline Haythornthwaite, Geof Bowker, Nick Burbules, Karen Lunsford & Melanie Huston. Provided introduction to "distributed knowledge processes" and ran exercises on the meaning of collaboration (see dkrc.org for details). Attendees (in addition to DK members): 15 students from various programs and one faculty member.

Distributed Knowledge Project (2003, July 17-18). *DK-DKRC Workshop,* Hosted by Bertram Bruce, Caroline Haythornthwaite, Geof Bowker, Nick Burbules, Chris Hagar, Michelle Kazmer, Karen Lunsford, Muzhgan Nazarova, Steve Poulakos, Rajeev Ramprakash, & Mihye Won. Allowed collaboration among two KDI Projects on campus, as well as with other researchers interested in Distributed Knowledge issues. Several disciplines and campuses were represented. Attendees (in addition to DK members): 6 graduate students, 5 faculty members.

Contractor, N., Cummings, J. N., Hinds, P. J., Monge, P. R., Bruce, B. C., Cramton, C., Fulk, J., Hollingshead, A., & Lomi, A. (2003, August 3). *Dynamics and outcomes of knowledge networks and distributed intelligence in work teams* [Professional Development Workshop]. Academy of Management 2003 annual meeting: Democracy in a knowledge economy, Seattle.

Publications and Products

1. Publications

*   **Journal publications**

Beach, R., & Bruce, B. C. (2002). Using digital tools to foster critical inquiry. In D. Alvermann (Ed.), *Adolescents and literacies in a digital world* (pp. 147-163). New York: Peter Lang.

Bishop, A. P., & Bruce, B. C. (2002). Usability research as participative inquiry. *Proceedings of the JCDL Workshop on Usability of Digital Libraries*.

Bowker, G. C. (2001). The knowledge economy and policy issues. In *Encyclopedia of Life Support Systems (EOLSS)*, Paris: UNESCO. Available at < http:// www.eolss.net>

Bowker, G. C. (forthcoming, book manuscript). *Memory practices in the sciences, 1830-1990*.

Bowker, G. C. (in press). Information technology. In *Oxford Encyclopedia on Science and Technology Studies*.

Bowker, G. C. (forthcoming, 2003). Time, money and biodiversity. In A. Ong and S. Collier (Eds.), *Global Anthropology*.

Bowker, G. C. & Star, S. L. (2002). How to infrastructure. In L. Lievrouw and S. Livingstone (Eds.), *Handbook of the new media*. London: SAGE.

Bowker, G. C., & Vann, K. (2002). Knowledge management in distributed collective practice. *Journal of the American Society for Information Science*, {{ }}.

Boyd, P., Hawisher, G. E.; Lunsford, K. J.; & Sheridan-Rabideau, M. P. (in press). Gaining privilege: Women negotiating the literacies of technology. In C. L. Selfe & G. E. Hawisher (with others), *Literate lives in the information age: Stories from the United States*. Mahwah, NJ: Lawrence Erlbaum.

Bruce, B. C. (2002). Diversity and critical social engagement: How changing technologies enable new modes of literacy in changing circumstance. In D. Alvermann (Ed.), *Adolescents and literacies in a digital age* (pp. 1-18). New York: Peter Lang.

Bruce, B. C. (2002). New technologies and social change: Learning in the global cyberage. In L. Bresler & A. Ardichvili (Eds.), *Research in international education: Experience, theory, and practice* (pp. 171-190). New York: Peter Lang.

Bruce, B. C. (2003). The role, value, and limits of S&T data and information in the public domain for education. In P. Uhlir (Ed.), *The role, value, and limits of S&T data and information in the public domain*. Washington, D.C.: National Academy Press.

Bruce, B. C. (Ed.) (2003). *Literacy in the information age: Inquiries into meaning making with new technologies*. Newark, DE: International Reading Association.

Bruce, B. C., & Bishop, A. P. (2002, May). Using the web to support inquiry-based literacy development .*Journal of Adolescent and Adult Literacy, 45* (8), 706-714.

Bruce, B. C., Bishop, A. P., Heidorn, P. B., Lunsford, K. J., Poulakos, S., & Won, M. (2003). The Inquiry Page: Learning with digital libraries. *Proceedings of the Joint Conference on Digital Libraries*.

Bruce, B. C., Bishop, A. P., & Robins, J. (2002). The Inquiry Page: A collaboratory for curricular innovation. *Proceedings of Computer Support for Collaborative*

Learning: Foundations for a CSCL Community (p. 746). Hillsdale, NJ: Lawrence Erlbaum Associates.

Bruce, B. C., Guzdial, M., Jones, C., Koschmann, T., Matusov, E., & Polin, L. (1998). Web-based collaboration: What makes it so hard? In A. S. Bruckman, M. Guzdial, J. L. Kolodner, & A. Ram (Eds.), *International Conference of the Learning Sciences 1998* (pp. 23-28). Atlanta, GA: Georgia Institute of Technology.

Bruce, B. C., & Levin, J. A. (2003). Roles for new technologies in language arts: Inquiry, communication, construction, and expression. In J. Flood, D. Lapp, J. R. Squire, & J. R. Jensen (Eds.), *Handbook of research on teaching the English language arts, 2nd edition* (pp. 649-657). Mahwah, NJ: Lawrence Erlbaum Associates.

Bruce, S. P., & Bruce, B. C. (2002). University students promoting science in the community. In R. Garner, Y. Zhao, & M. Gillingham (Eds.), *Hanging out: Community-based after-school programs for children* (pp. 41-58). Westport, CT: Greenwood.

Burbules, N. C. (forthcoming). Virtual reality. In J. Collins & N. O'Brien (Eds.), *Oryx dictionary of education*. Phoenix, AZ: Oryx Press.

Burbules, N. C. (2002). The global context of educational research. In L. Bresler & A. Ardichvili (Eds.), *Research in international education: Experience, theory, and practice* (pp. 157-169). New York: Peter Lang.

Burbules, N. C. (2002). The Web as a rhetorical place. In I. Snyder (Ed.), *Silicon literacies* (pp. 75-84). London: Routledge.

Burbules, N. C., & Bruce, B. C. (2001). Theory and research on teaching as dialogue. In V. Richardson (Ed.), *Handbook of Research on Teaching, 4th edition* (pp. 1102-1121). Washington, D.C.: American Educational Research Association.

Burbules, N. C., & Lambeir, B. (forthcoming). The importance of new technologies in promoting collaborative educational research. In P. Smeyers & M. Depaepe (Eds.), *Beyond empiricism: On criteria for educational research*. Leuven, Belgium: University Press of Leuven.

Comstock, S. L., Bruce, B. C., & Harnisch, D. (2003). The Inquiry Page: Collaborative technology into practice. In *Proceedings of the Society for Information Technology and Teacher Education, International Conference*. Norfolk, VA: Association for the Advancement of Computing in Education.

Comstock, S. L., Harnisch, D., Bruce, B. C., & Mehra, B. (2002). Who's teaching whom? Scientist/teacher teams and administrative strategies. In *Proceedings of ED-MEDIA: World Conference on Educational Multimedia, Hypermedia and Telecommunications* (p. 342). Norfolk, VA: Association for the Advancement of Computing in Education.

Fischer, H., Brown, J., Porac, J. F., Wade, J. B., DeVaughn, M., & Kanfer, A. (2001). Mobilizing knowledge in interorganizational alliances. In N. Bontis and C. W. Choo (Eds.), *The strategic management of intellectual capital and organizational knowledge: A collection of readings*. Oxford University Press.

Garton, L., Haythornthwaite, C. & Wellman, B. (1999). Studying online social networks. In S. Jones (Ed.), *Doing Internet research* (pp.75-105). Thousand Oaks, CA: Sage.

Haythornthwaite, C. (1999). Work and community in networked organizations. In Leen d'Haenens (Ed.). *Cyberidentities: Canadian and European presence in cyberspace* (pp. 135-145). Ottawa, Ont.: University of Ottawa Press.

Haythornthwaite, C. (2002). Building social networks via computer networks: Creating and sustaining distributed learning communities. In K.A. Renninger & W. Shumar, *Building Virtual Communities: Learning and Change in Cyberspace* (pp. 159-190). Cambridge, UK: Cambridge University Press.

Haythornthwaite, C. (forthcoming, 2003) Online communities of learners. *The Encyclopedia of Community*. Sage.

Haythornthwaite, C. & Kazmer, M.M. (2002). Bringing the Internet home: Adult distance learners and their Internet, Home and Work worlds. In B. Wellman & C. Haythornthwaite (Eds.), *The Internet in everyday life* (pp. 431-463). Oxford, UK: Blackwell.

Haythornthwaite, C. & Kazmer, M.M. (October, 2003). Distributed knowledge practices and ICT. Paper to be presented at the Annual Meeting of the Association of Internet Researchers, Toronto, Canada.

Haythornthwaite, C. & Kazmer, M.M. (Eds.) (in preparation). *Learning, culture and community: Multiple perspectives and practices in online education*. Peter Lang.

Haythornthwaite, C. & Wellman, B. (Eds.) (2001). *The Internet in Everyday Life*. Special issue of the *American Behavioral Scientist, 45*(3), whole issue. [noted in the July 26, 2001 section of the NYT called Circuits. "Cyberspace Isn't So Lonely After All" By Lisa Guernsey.]

Haythornthwaite, C. & Wellman, B. (2002). Introduction: Internet in the everyday life. In B. Wellman & C. Haythornthwaite (Eds.), *The Internet in everyday life* (pp. 3-44). Oxford, UK: Blackwell.

Kanfer, A., Bruce, B. C., Haythornthwaite, C., Burbules, N., Wade, J., Bowker, G. C., Porac, J. (2000). Modeling distributed knowledge processes in next generation multidisciplinary alliances. In *Conference Proceedings of Next Generation Enterprises: Virtual Organizations and Mobile/Pervasive Technologies, April 27-29, 2000*. Buffalo, NY: Academic-Industry Working Conference on Research Challenges '00 (AIWORC '00).

Lastra, S. (2001, January). Harvesting community knowledge. *Proceedings of the 34th Hawaii International Conference on System Sciences*. Los Alamitos, CA: IEEE Computer Society.

*Books or other non-periodical, one-time publications

Beach, R., & Bruce, B. C. (2002). Using digital tools to foster critical inquiry. In D. Alvermann (Ed.), *Adolescents and literacies in a digital world* (pp. 147-163). New York: Peter Lang.

Bishop, A. P., & Bruce, B. C. (2002). Usability research as participative inquiry. *Proceedings of the JCDL Workshop on Usability of Digital Libraries*.

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Bowker, G. C., & Vann, K. (2002). Knowledge management in distributed collective practice. *Journal of the American Society for Information Science*, {{ }}.

Boyd, P., Hawisher, G. E.; Lunsford, K. J.; & Sheridan-Rabideau, M. P. (in press). Gaining privilege: Women negotiating the literacies of technology. In C. L. Selfe & G. E. Hawisher (with others), *Literate lives in the information age: Stories from the United States*. Mahwah, NJ: Lawrence Erlbaum.

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2.   Website

DK Project. <http://www.dkrc.org/KDI/>.

DKRC. <http://www.dkrc.org>. Two graduate students, Steven Poulakos and Rajeev Ramprakash, have significantly revised and expanded the DKRC Website. The new site better reflects the needs of the members of a larger consortium of Distributed Knowledge researchers. Technologies have been developed and/or incorporated into the site to facilitate the following:

- dialogues via web accessible email archives, Web logs and Inquiry Units
- building collections of resources that include bibliographies, conference listings, and technology descriptions
- guiding activities for our members with a new mailing list for discussing current activities of the DKRC community
- organizing sub-DKRC groups through Community Inquiry Lab technologies, which allow a person or people a simple mechanism for creating their own space on the Web, which utilizes many of the same tools that we provide on the DKRC.

The new website was unveiled at our July 2003 Workshop and was introduced to the whole DKRC community in August 2003 at the Academy of Management conference.

Inquiry Page. <http://inquiry.uiuc.edu>. The Inquiry Page is one of the various collaborative technologies used to support distributed work, which the DRKC members have been using and investigating. The Inquiry Page now has users around the world.

There are about 500 subscribed to the main discussion list and around 2000 Inquiry Units posted. The site has become an integral component of about a dozen research projects on the UIUC campus and another half-dozen proposals.

Numerous publications have already emerged from the Inquiry Page work. Byungro Lim at Indiana University completed his dissertation (2002) on a comparative analysis of three systems, including the Inquiry Page; Jenny Robins wrote hers on Stone Soup (2003), a variant of the Inquiry Page; Karen Lunsford in English wrote hers (2003) on distributed argumentative activity, with a concluding chapter on co laboratories and a discussion of how to use the Inquiry Page to teach argumentation. At least three other students at UIUC are using it or studying it in theirs.

The Inquiry Page is a practical, award-winning educational extension of our research into how people learn and collaborate in distributed environments. Several other research groups also now support The Inquiry Page, and together we have created resources to increase the functionality of online, collaborative workspaces. We call the sharing of these resources "distributed inquiry." Each contributing group may now tag its own inquiry units yet also share them with other groups and the public, maintain a group-specific as well as collective events calendar, and access a dynamic member directory.

Community Inquiry Laboratory Builder. <http://inquiry.uiuc.edu/cil>. See "Contributions" for details.

3.   *Other specific products*

For the first two years, we focused primarily on technologies that allowed DK to collect and share information on the groups under study. These tools facilitated our video/audio conferencing, interview transcription, and social network analyses. As the DK group itself became distributed, we also began to implement technologies to further support our need for interdisciplinary collaboration. To that end, we have adopted and adapted tools to support individual or small-group projects as well as research efforts undertaken by the whole DK team:

> Distributed bibliography: We have combined and modified several digital library tools to create and maintain a distributed, online bibliography. It allows individuals/small groups to collate their own collection and to tag materials according to a unique category name. At the same time it allows large groups to compile materials from several sources, which has facilitated the collection of almost 500 entries, which pertain to distributed knowledge issues.

> Blogs: A renewed, public interest in blogs (or web logs) has caused us to re-assess our own blog use, so that we are now employing them to create dynamic, collaboratively generated pages for our DKRC website. A blog is a web page made up of usually short, frequently updated posts that are arranged chronologically—like a what's new page or a journal. The content and purposes of blogs varies greatly—from links and commentary about other websites, to news about a company/person/idea, to diaries, photos, poetry, mini-essays, project

updates, even fiction. Utilizing a Web-based tool, Blogger, created by Pyra Labs, the DK group is able to create a reverse chronological, annotated bibliography of the website visited by group members. The tool provides a convenient way to capture the URL and desired text of a web page. It also allows for the creation of personalized annotations about the URL being blogged. The blogs may be conveniently grouped into predefined topics that DK members create.

B2W (BibTex to Web). This tool was developed by Jun Wang at UIUC to provide a portal Web resource on a research project involving multiagent systems and language evolution. We have modified it to meet some of the requirements of DKRC users. For more information, please visit: http://www3.dkrc.org/bib/dkrc/ The DKRC has used this software to organize bibliographic collections by both projects (see Category) and topics (see Keyword). We have found this program to be very useful in organizing and displaying our resources.

DMOZ Open Directory Project: http://dmoz.org. The Open Directory Resources of DKRC is run by Bertram Bruce. It is specially designed to search for resources online for his courses, so that students can find something on relevant topics to read according to their interests. For example, it supports the Distributed Knowledge Seminar taught by Bertram Bruce and Caroline Haythornthwaite. In addition, by developing categories like Distributed Knowledge, Knowledge Creation and Retrieval, it crosses over to a useful place to hold information about knowledge for DK members to look at.

Greenstone. Greenstone is a suite of software for building and distributing digital library collections. (http://www.greenstone.org/english/home.html) . It provides a new way of organizing information and publishing it on the Internet or on CD-ROM. Greenstone is produced by the New Zealand Digital Library Project at the University of Waikato, and developed and distributed in cooperation with UNESCO and the Human Info NGO. It is open-source, multilingual software, issued under the terms of the GNU General Public License. The DKRC had experimented with this software when searching for a tool for displaying our bibliographic resources via the Web.

IKNOW. IKNOW (Inquiring Knowledge Networks on the Web) is a Web based E-solution that was created to assist organizations, communities, or individual team to manage their knowledge assets.(: http://www.spcomm.uiuc.edu/Projects/TECLAB/IKNOW/). The DKRC explored ways of integrating I-KNOW with the tools that DKRC members currently use. The goal is to better visualize the knowledge sharing and co-construction activities that occur within our DKRC community.

Krackplot. KrackPlot is a program for network visualization designed for social network analysts. It runs on Dos systems, but there is now an experimental web interface using forms (http://www.contrib.andrew.cmu.edu/~krack/)

Transcription Tools. DKRC used the new technology which is used for producing a text version of an audio or visual interview. Karen Lunsford is the person most familiar with the technology in the DK group. Apart from the common transcription tool mentioned

above, she also had experience with a voice recognition software, which, although does not recognize voices on tapes, is able to transcribe what people repeated from a tape to the program into text automatically, including punctuations. The biggest advantage of it is to save people's hands from writing or typing. However, DK members run into some problems while using the tools. The most significant problem up to now is that the technology needs someone to mediate between digitized information and text, which means that a person has to interpret to a transcription machine or program what was being said on digitized material. As the DK group has just started to test the tools, its members will try out different kinds of tools to see which ones are superior to others and what improvements can be made to them. In this way, DKRC gives feedback to developers of the technology and makes recommendations to users of the products.

Contributions

1 Principal discipline(s) of the project

sociology, education, computer science, history, business, psychology, philosophy, information science

2. Other disciplines of science or engineering

cosmology, environmental hydrology, molecular biology, chemical engineering, nanomaterials, scientific instrumentation

3. Development of human resources

Awards and Honors

- Nicholas Burbules was appointed to Grayce Wicall Gauthier Professorship, College of Education, University of Illinois (2002-2007).

- Bertram Bruce edited a book *Literacy in the information age: Inquiries into meaning making with new technologies*. Newark, DE: International Reading Association, 2003, which was selected as the March 2003 Book of the Month by the International Reading Association.

- Bertram Bruce's paper entitled "The Role, Value, and Limits of Scientific and Technical (S&T) Data and Information in the Public Domain for Education" has been made available by National Academies Press as part of a set of proceedings in honor of the anniversary of the National Academies Public Domain Symposium.

- Caroline Haythornthwaite was appointed Interim Associate Dean, Graduate School of Library and Information Science, University of Illinois, Urbana-Champaign (2002-2003).

- The article written by seven DKRC researchers (Alaina Kanfer, Bertram Bruce, Caroline Haythornthwaite, Nicholas Burbules, James Wade, Geof Bowker, Porac,

J.) Modeling distributed knowledge processes in next generation multidisciplinary alliances. Buffalo, NY: Academic-Industry Working Conference on Research Challenges '00 (AIWORC '00), 2003 received Bell Atlantic Best Paper Award.

- Michelle Kazmer received Berner-Nash Award for Outstanding Dissertation awarded by the Graduate School of Library and Information Science, University of Illinois, Urbana-Champaign, in 2003 for dissertation *Disengagement from intrinsically transient social worlds: The case of a distance learning community* completed in 2002.

- Karen Lunsford, K. J. was appointed as a John Bardeen Scholar, Center for Advanced Study (One of four University-wide, competitive graduate fellowships), University of Illinois (2000-2001).

- First Place was awarded to The Inquiry Page in the Technology Design Competition for the category of "Rhetoric and Writing in K-12 Education." Presenters: Bertram C. Bruce, Melanie Huston, & Karen J. Lunsford. Computers & Writing 2001 Conference, May 21, 2001.

Dissertations

The following dissertations have been successfully completed as a result of the grant:

- DeVaughn, M. (2002—defended). *Regulatory protectionism and learning in the US commercial banking industry: An exploration of survival enhancing learning in new banks*. Business Administration. University of Wisconsin-Madison.

- Kazmer, M. M. (2002). Disengagement *from intrinsically transient social worlds: The case of a distance learning community*. Graduate School of Library and Information Science. University of Illinois, Urbana-Champaign.

- Lunsford, K. J. (2003). Distributed *argumentative activity: Redefining arguments and their re-mediation from a sociohistoric perspective.* English Department / Writing Studies. University of Illinois, Urbana-Champaign.

- Robins, J. (2003). *The role of a mediating information structure in a contextualized system*. Graduate School of Library and Information Science. University of Illinois, Urbana-Champaign.

- Vann, K. (2001). *The duplicity of practice*. Department of Communication. University of California, San Diego.

4.   Physical, institutional, or information resources that form the infrastructure for research and education

See "Publications and Products".

5. Other aspects of public welfare beyond science and engineering, such as commercial technology, the economy, cost-efficient environmental protection, or solutions to social problems

Our work on Community Inquiry Laboratories has supported social justice work in the Marshall Islands, the Paseo Boricua community in Chicago, Sisternet, an organization of African-American women concerned about healthcare, the East St. Louis Action Research Project, and numerous other projects.

Community Inquiry Labs are a primary means to engage in research and practice related to learning with people from all walks of life. A community inquiry lab (CIL) is a place where members of a community come together to develop shared capacity and work on common problems. We use "community" to emphasize support for collaborative activity and for creating knowledge that is connected to people's values, history, and lived experiences. "Inquiry" emphasizes support for open-ended, democratic, participatory engagement. "Laboratory" suggests a space and resources to bring theory and action together in an experimental and critical manner. A CIL is most importantly a concept, although we are developing web-based tools to support community inquiry online. For a listing of existing CILs, see http://inquiry.uiuc.edu/cil .

CIL's provide an action-based means to address a variety of questions, such as: How does learning occur in diverse educational settings? How is creativity expressed as we engage in learning? How do people develop the literacy they need for full participation in the society they live in? Underlying their implementation is a long tradition of scholarship and social action by Addams, Dewey, Freire, and others, Glassman (2001) notes that the "disturbed equilibrium" that occurs when knowledge held by diverse individuals comes into contact--and conflicts--is the necessary grounding for true learning and change in a democratic society.

The development of CIL's requires us to consider additional questions, including: How can we craft digital tools and resources that promote the establishment and maintenance of vibrant communities of inquiry? How can we more fully incorporate the circumstances and experiences of learners who live on the racial, economic, cultural, or linguistic margins of mainstream society (Friere, 2002; Kozol, 1991)?

We engage these questions through participatory action research. This research actively involves local residents as co-investigators on an equal basis with university-trained scholars in each step of the research process. It typically defines a nonlinear course throughout the investigation as the problem being studied is 'reframed' to accommodate new knowledge that emerges.

Currently, we are engaged in participatory action research (Greenwood & Levin, 1998; Stringer, 1999; Whitmore, 1998) and the development of CIL's with several important partners in diverse communities. In Champaign-Urbana, we have worked for more than five years with SisterNet (led by Imani Bazzell), a grassroots social network that embodies an innovative model for Black women's organizing through its learning and

action circles (http://sisternetonline.org). SisterNet women engage in educational activities that represent wholeness through physical, emotional, spiritual, and intellectual health. They also develop political strategies to resist oppression and shape livable communities. Our collaborative work with SisterNet women, in fact, resulted in the original design of web-based community inquiry labs (Bishop, et al., 2001; in press).

A recent project involves community work on issues of culture, health, education, economics, and law affecting the Marshall Islands and the Marshalese today. A key issue is to understand the effects of US bomb and missile testing on the people of the Marshall Islands, and to seek ways to improve the current situation. Through a community inquiry lab, students at the University of Illinois and several other universities learn through their collaboration with Marshalese and with others who have lived and worked in the Marshalls,.

We also participate in a community of inquiry based in the 30-year old Puerto Rican Cultural Center (PRCC) in Chicago's Humboldt Park neighborhood <http://www.prairienet.org/pbclp>. The PRCC galvanizes neighborhood residents around multi-generational community projects that address critical local issues such as gang violence, AIDS, social and environmental justice, literacy, cultural preservation, and economic development. Their projects include: the Café Teatro Batey Urbano for youth, an AIDS/HIV education and outreach center called Vida/SIDA; a high school, pre-school, and family learning center; the Paseo Boricua Community Library Project; a museum and performance plaza built by the high school students; and, most recently, Street Academy courses whose work is facilitated through CILs.

The East St. Louis Action Research Project http://eslarp.uiuc.edu , is a longstanding collaboration that involves faculty and students from a range of University of Illinois departments. ESLARP explicitly seeks to build capacity and attain immediate improvements in local conditions (Reardon, 1998, p. 59). The Digital East St. Louis collaborative is spearheaded by Prairienet, the community network that is based in GSLIS and directed by Paul Adams. Working with neighborhood churches, libraries, schools, and community groups though the East St. Louis Neighborhood Technical Assistance Center, faculty and students have installed over 20 community technology centers (many with wireless computer labs) and are delivering a range of educational activities. This set of community inquiry activities has been supported through participants' creation of online inquiry units that take the form of action plans and project reports.

CILs achieve a number of critical goals related to bridging theory and action. They support collaborative research on learning that will lead to more accurate findings and theories because they are inclusive of the situations, experiences, and perspectives of the full range of society. They provide for two-way knowledge transfer in the realm of learning: university researchers have the opportunity to inform their work by collaborating with people from all walks of life in developing theories and experimenting with practice.

CILs provide a general, easy to use, web-based infrastructure for communication and collaboration. More importantly, they help build relationships based on equitable participation and trust among all members of an inquiry community. They form a conceptual and practical framework for a wide range of learning activities, including the processes of information system design and evaluation.

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