Evaluating the Use of a Geographic Digital Library in Undergraduate Classrooms: ADEPT

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ABSTRACT

The evaluation plan for the Alexandria Digital Earth Prototype (ADEPT) centers on two investigations: a study of classroom use of the system by faculty and students and lab-based usability studies. The classroom-based study is primarily an investigation of the digital library's impact on student learning, using multiple research methods. The five-year work plan includes investigations of the use of ADEPT in non-geography classes.

KEYWORDS: End-user evaluation, student learning, usability study.

Digital library research tends to focus either on the development of experimental digital library systems or on the development of digital library services [1]. These approaches are complemented by a growing concern about the effectiveness of digital libraries, not only in terms of information seeking and retrieval, but also in terms of how they can directly enhance learning. Systematic evaluation plans are essential components of digital library research projects to assess whether design objectives have been accomplished and whether services are effective.

ALEXANDRIA DIGITAL EARTH PROTOTYPE (ADEPT)

The Alexandria Digital Earth Prototype (ADEPT) is an extension and enhancement of the Alexandria Digital Library (ADL), developed under the first Digital Libraries Initiative (1994-1998), and based at the University of California, Santa Barbara. ADL is now an operational digital library (as part of the California Digital Library) that allows users scattered across the Internet to access collections of maps, images, and other geo-spatial and geo-referenced materials. ADEPT is funded under the second Digital Libraries Initiative (DLI-2, 1999-2004), and will provide a broad variety of analysis tools and modeling services that will permit users of ADL's collections to construct their own personalized digital libraries from information available over the Internet and to use these 'virtual' digital libraries in creative ways in collaboration with other users.

In particular, the project will focus on supporting uses in classroom instruction in a variety of disciplines, including the arts, humanities, and social, physical, and biological sciences. To do so, ADEPT is employing the *digital earth* metaphor for organizing, using, and presenting information at all levels of spatial and temporal resolution through digital environments known as *Iscapes* (information landscapes).

EVALUATION OF ADEPT

UCLA is a partner with UCSB in the education and evaluation of ADEPT. We are conducting a five-year investigation of technology-supported learning, focusing primarily on the classroom use of ADEPT by examining its impact on student learning and teaching behavior in undergraduate classes at UCLA and UCSB. ADEPT offers a rare opportunity to evaluate learning activities and integrate the assessment results into the design of the system. The classroom evaluation component of ADEPT will assess learning outcomes as a result of implementation of successive ADEPT prototypes in undergraduate classrooms, first in geography and subsequently in other subject areas where geographic information may be useful (for example, urban planning, environmental studies, archaeology, and public health).

We are employing a variety of research methods, including intensive analyses of individual users and large-scale studies of entire classrooms, using multiple dependent measures such as analyses of problem-solving processes, quantitative analyses of learning outcomes, and qualitative descriptions of user misconceptions. These converge on understanding how people learn using the ADEPT system. ADL prototypes already developed have been instrumented for sophisticated data collection, including transaction logging and surveys [4]. We are now extending these capabilities in ADEPT [2]. Results of the usability and evaluation studies will provide continuous feedback to the design of ADEPT services, functionality, and choice of collections.

The promise of digital libraries and systems like ADEPT is that they open up learning opportunities for students, provoking them to be active learners in locating relevant information, balancing evidence, synthesizing knowledge, and developing their own conclusions. Classroom studies

will address questions such as these: How does ADEPT influence student learning of geographic concepts and processes? How effective are the use of Iscapes and the Digital Earth metaphor in facilitating ADEPT use? Does student collaboration increase as a result of working with ADEPT? In what ways might the pedagogical methods employed by faculty change as a result of implementing ADEPT in their teaching activities?

As a starting point for classroom studies we are gathering baseline data about the performance and demographics of classes in the same subject area for the five preceding years, as well as information relating to faculty teaching practices and pedagogical objectives. This forms a part of a needs analysis designed to identify faculty and student users, their tasks, task context, and what tools, content, collections, and metadata might be usable in their environment. Formative evaluation builds upon the needs analyses and will continue throughout the project, since needs will change as the system develops and becomes increasingly integrated into classroom instruction. Summative evaluation will begin midway through the project, by triangulating quantitative and qualitative methods to assess short and long-term learning and instructional methods.

Classroom studies are focussing on three aspects derived from the key questions outlined above. These are: (1) the usability of ADEPT in multiple disciplines, (2) faculty activities in integrating ADEPT into undergraduate classrooms, and (3) learning outcomes associated with use of ADEPT.

We also are conducting laboratory-based usability studies. These address cognitive analysis of users' mental models and problem-solving processes based on various interface designs. First, we are assessing users' mental models at various points in their learning of the system in order to determine how users' mental models develop over time, and then compare how the quality of users' mental model is related to performance on various search tasks using the system [3, 5]. Second, we are examining the effects of incorporating various multimedia-based metaphors in the interface on improving users' mental models and their performance. Evidence is mounting that multimedia-supported metaphors -- such as the Digital Earth -- can be powerful aids for student learning [6, 7]. We will compare the cognitive consequences of using various kinds of metaphors for the search process. These studies have implications for interface design as well as for cognitive theories of technology-based learning.

While evaluating new technologies such as digital libraries in real-world settings is essential to determining their value and benefits, such evaluation is notoriously difficult to accomplish. We are aware of the limitations of such research, and of the need to develop and adapt new research methods. Prototype digital libraries and emerging services evolve over the course of an evaluation, and thus we are studying a moving target. Similarly, costs associated with "bleeding-edge" applications may not adequately predict the costs of follow-on efforts. A related concern is that solutions developed for experimental or demonstration projects may not adapt readily to large-scale implementation. With these limitations in mind, the research begins with baseline data collection about how courses currently are being taught, and incorporates longitudinal measures of learning and instruction over a multi-year period. Research methods will be adapted accordingly.

WORKPLAN AND SCHEDULE

This first academic year of the project is devoted to requirements analysis and evaluation design. Prototype Iscapes will be deployed in the spring term (April to June, 2000) at UCSB and UCLA. Baseline data collection began in the fall term (September-December, 1999). Later years of the investigation will study the impact of ADEPT in non-geography classrooms (for example, urban planning), and will track whether students continue to use ADEPT for work in courses that do not make direct instructional use of the experimental digital library.

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