A Web–based interdisciplinary project at Acadia University allows students to become active participants in their own learning process.

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Acadia University is the first laptop university in Canada. The Acadia Advantage program has each incoming student and each faculty member equipped with a laptop computer. In addition, classrooms, the library, residence rooms, and common areas are wired so that the network is accessible both in and out of classrooms. This initiative has been accompanied by an educational paradigm shift from an instructor-centered to a learner-centered model. In this article we will describe one example of the new class of learning support tools needed to take advantage of the reality of student-centered, mobile technology. We show, by example, how the technology can be used to integrate the student experience inside and outside the classroom and, perhaps more important, within the campus community and within the world community. The Digital Agora is an ambitious interdisciplinary project that supports the understanding and analysis of complex issues in the social sciences within this new environment, using the Web for connectivity both on campus and off campus.
As a source of pedagogical support for political science, the Digital Agora focuses on computer tools that enhance the process of discovery of viewpoints, analysis of issues, presentation, and discussion. We examine both how we exploited many of the features of the Web and the limitations the Web imposed on our design.

This project recognizes the need for educational support that goes beyond accessing information [8] and the importance of collaboration in solving complex problems [6]. The Digital Agora provides a Web-based system that facilitates the collaborative analysis of complex problems, such as peace initiatives, bioethics questions, consensus negotiations, and environmental issues. In these areas, a huge amount of information is available and may be dispersed among many sites and represent divergent points of view. The Digital Agora allows users to access this dispersed information, organize it, and work collaboratively in understanding and resolving these complex issues. The Digital Agora was developed at Acadia University and is now being used in three political science courses on campus: international politics, peace studies, and introductory political science.

A goal in designing the Digital Agora [4] was to provide an environment in which participants from a variety of backgrounds can appreciate different points of view on complex issues, formulate coherent analyses, and generate well-articulated and well-reasoned positions on issues. Participants, therefore, need to do more than just access and read position papers on the Web. They need to discuss issues, extract key elements, articulate ideas, and formulate responses. The participants need to be producers as well as consumers of information, that is, active participants as well as audience. Figure 1 shows the home page of the current implementation of the Digital Agora, with many of the components available to the participants.

The Digital Agora is a Web-based hypertext design that provides authorship of nodes and links, discussion groups, collaborative analysis, simulations, and graphical representations of complex issues using lateral maps.

A goal of the project is to support the following functions:
• Access to primary data, such as census data or government policy
• Access to secondary data, such as reviews or instructor notes
• Simulations, such as economic forecasts or population growth
• Generation and editing of lateral maps
• Quizzes and evaluations
• Presentations
• Discussion groups, both open and moderated
• Consensus negotiation
• Collaborative writing
• Shared and private hypertext links
• Typed hypertext links on the Web
• Student authorship, such as composition of new nodes and annotations

Another goal of the project is to provide a tool that integrates many of the resources already available to the students into a coherent environment that can be used cooperatively for studies in a range of disciplines.

In this article, we examine how we exploited many of the features of the Web in implementing the Digital Agora to make it a novel and innovative collaborative space to support the analysis of complex issues. We also explore the limitations imposed on our design by the Web and discuss some of our approaches to overcoming or working around these limitations.

The Digital Agora and the Web

The Digital Agora is an information resource and workspace application whose users are typically students, faculty, and advisers from a variety of institutions, both national and international.

There are some obvious and compelling reasons for implementing collaborative applications, such as the Digital Agora on the Web, including the following:

Scale up. The Web provides us with a huge playing field in which 10 or 10,000 users can participate. Issues of scale up are largely those of bandwidth and storage requirements.
Lateral maps. As visual representations of arguments and analysis, lateral maps may be prepared by faculty members or students. They are presented as either images or converted PowerPoint slides. Figure 2 shows a sample lateral map dealing with the development of a charter, in this case the Canadian Charter of Rights and Freedoms. In this lateral map, the student is expressing his or her view that societies have different ideas about what rights should be entrenched in a charter. Further, within a particular society, there will likely be clashes among different groups and individuals about which rights to embed, and rights may also conflict with each other. Many of the images used in the composition of lateral maps are chosen from a common pool of such images, called the “symbol bank” (described later). In Figure 2, the “s” is the symbol for “society” and the red splash is the symbol for “conflict.” Over 1,200 lateral maps are currently available for the students on a wide range of topics, from international examples of federalism to multiculturalism.

Tutorials. Video enhanced tutorials are available on such topics as essay writing and presentation.

Political Byte. Each class or group can use this facility to generate an online student newspaper dealing with issues relevant to the current topics of discussion, featuring current events, historically relevant events, photos, and editorials. Figure 3 shows the front page of a sample edition created by students.

Symbol bank. A shared symbol bank is available, with annotations so that students making lateral maps can use symbols that have a shared semantics. The use of a common set of symbols makes linkages more apparent and the maps easier to understand. Figure 4 shows the symbol bank entries for two of the symbols, “society” and “conflict,” used in the lateral map in Figure 2.

Glossary. A glossary of commonly used terms for political science discussion is maintained for the use of all participants. The glossary is set up in layers, each of which provides more comprehensive coverage of the term.

Chat room. Each course has one or more chat groups, supported by software written at Acadia for use by classes [1].

Calendar. A Java calendar that all participants can use is included. It has public (all participants), course (members of a course), group (members of a collaborative group) and personal calendar views. Participants can view and edit calendars for which they have permission.

Cabinet room. This is a class-based collaborative space for discussions.

What's new. Course and general announcements are posted here.
The Gallery is a collection that demonstrates, by example, how political ideas are portrayed in art, music, and literature. It helps students tie their ideas into other disciplines. The sample in Figure 5 shows the top page for the Gallery.

FAQ. FAQ services are maintained by the students both for individual courses and for the Digital Agora in general.

Trivia. A revolving set of trivia questions and mystery photos are posted here to challenge students and faculty.

A bout. The overview of the Digital Agora project and guidelines on its use are found here.

Guest book. A standard cgi-script guest book allows visitors to register and provide feedback.

Political science students can use computer tools to enhance their learning environment. These tools can provide support for the following steps: the discovery and assimilation of information from various points of view; the formulation of an analysis of a problem; the presentation of that analysis; the discussion, defense, and amendment of the analysis; and finally, the derivation of conclusions. Implementing the Digital Agora on the Web opens up a vista of communication and connectivity opportunities for students and faculty, including access to many more primary and secondary sources, discussion groups, class newsletters, and shared documents. Large amounts of data (text, photos, videos, and audio) are available from many different sources, including universities, governments, archives, non-governmental organizations, and individuals. The Web gives us a platform that all of the participants are familiar with and that can be updated on a continual basis.

The primary and secondary source materials, which include multimedia components, are stored both on Web sites and on the Digital Agora CD-ROM [4]. Government and organizations are responsible for maintaining the primary data at their own sites. Instructors generate largely secondary material for use by the students: hot lists, annotations, indices, and examples of analysis. Students and other participants can also generate data, which may be multimedia (text, image, video, and audio). A key component in this environment is the use of lateral maps as a means of complementing...
communication with a visual interpretation. Lateral maps [3] are an informal and personal style of concept maps, which have been used for many years in other disciplines [5, 7]. Lateral maps are a specialized graphical presentation format that facilitates the communication of understanding of issues and relationships relevant to a complex situation. Individual students and student teams create concept nodes and links representing their own analysis or view of a situation. Lateral maps provide a means of building connectivity between ideas, and students may include connections to other maps, textual material, visual or audio material, and, of course, Internet Web sites.

Information can also be created dynamically by other applications for visualization or one-time use [2, 11] by users of the Digital Agora, particularly for negotiation, visualization, and simulation. For example, simulation applications, such as those for economic systems or stock markets, allow students to engage in time-based and “what-if” analyses.

Table 1 presents a summary of the opportunities presented to students to become active participants in their own learning process as readers, authors, and collaborators.

**Limitations of the Web**

The Web provides universal access to huge distributed repositories of text and data that may be relevant to analyses in the political sciences but only rudimentary tools for facilitating the understanding of the complexity of issues, the formulation of strategies for dealing with these issues, and finally, the communication of ideas. There are some remaining implementation issues that we found problematic on the Web, including lateral map construction, node and link authorship, typed links, privacy levels, fast and consistent storage, and navigation aids.

The lateral maps are key components of the student analysis and argumentation and are currently presented as images only. A lateral map, like that shown in Figure 2, is similar to a concept map [7], except that the author has much more latitude in the objects and relationships used in its construction. Currently, the students use PowerPoint to construct multislide, animated, and interconnected lateral maps that represent their view of an argument or model of a complex issue. Web browsers can handle the slides for presentation purposes but lack a facility that the students can use, either individually or collaboratively, for significant map construction.

The Web supports shared documents that are bitmaps but not the more sophisticated semantic objects needed in the Digital Agora. Although many of the lateral maps are part of the persistent resource data set, their actual construction also plays a significant role for participants in the discovery of essential components of an issue. Consequently, a student or a group of students needs to be able to build virtual lateral maps that last only long enough for the student(s) to build a coherent analysis or discuss issues with a colleague. Furthermore, to be useful in discussion these maps need to have a semantic decomposition rather than only a bitmap representation. In other words, the various semantic components of these lateral maps must be objects that can be moved, labeled, and relinked to other components of the map.

A lateral map can be a vehicle for students to use to reach agreement on the essential components and relationships of a complex issue by working on one map together. We are working on an object-oriented lateral map tool that will allow collaboration in the construction of lateral maps based on visual representations of objects that can be moved around, labeled, colored, and so forth, but that are stored as data objects rather than as bitmaps and are reconstructed as needed.

Although the Web supports users as authors, it does so in a very restricted manner. Users can create their own documents and their own links but cannot do such things as add links to other documents, or annotate other documents. There exists a very well defined distinction between user as reader and user as author.

The merging of the reader and author roles is a crit-
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Links on the Web are the simplest type, goto, although it is generally accepted that task-oriented applications often require semantic types, collaborative links, and fat links [12]. Simple goto links are too semantically impoverished to provide a basis for the construction of complex arguments. The Digital Agora requires links that support the semantics of links as relationships between information components, such as links that denote a specific relationship between the current node and the destination node. These relationships would include both predefined and user-defined types, such as example of, annotation, in support of, contrary to, same source, same topic, and aggregation.

Relationship links can be used for directing coherent, reasoned argumentation. The use of relationships to formalize the structure of reasoned discourse is well established [9, 10]. Relationship links are fundamental to the goal of coherent analysis and the subsequent communication of concepts related to complex problems. Measured consideration of issues also requires relationship links, such as macroscale, microscale, in support, not supporting, previous argument, and example of. In addition, students, instructors, and institutional participants need to be able to create as well as follow typed links that define the semantics of their inquiry or position. Participants must be able to differentiate among links by type, base searches on link type, and modify link type as required. Readers should be able to generate such links from Web documents they do not own, generating a special class of private links.

We are currently working on a Web tool that supports the authorship and navigation of semantically typed links and also supports links to and from Web documents that may or may not be owned by the reader. These links are being implemented as separate objects; that is, they are not embedded in the documents but managed by a separate layer. This approach allows us to implement various levels of access control as well.

The design of the Digital Agora requires the flexible support of links that can be designated as private, shared, or public. While a participant is formulating an analysis he or she may need to designate links that are private, that is, visible and instantiable only by the owner, or shared, that is, usable only by members of a collaborative group. At some point in time, they may open up these links and make them public, so that they are widely available and become part of the public persistent link presence. Private links that originate from public resource sites and point to participant sites may also be desirable. For example, members of a collaborative group may designate links from a concept in the reference site to one or more individual nodes that are accessible only by members of the group. The Web provision for password protection is too rigid and clumsy to alter.

Currently, most Web links are owned and controlled by the creator of the document and made available to everyone with access to that site. In a collaborative environment, there is a need for private reader-generated links. Private reader-owned links are links that a reader (that is, nonowner) of a document has created to provide a link for that reader or reader group from someone else’s node. These links would be owned and managed by the reader, not by the actual owner of the document. Thus, a reader should be able to incorporate someone else’s Web document into the reader’s hypertext without the knowledge of the author of the document. Of course, this leads to the problem that the owner of the Web document may change or move the document and the reader-gener-
ated links may become incorrect or broken. Currently, access to large data sites, such as video or images, is slow and unreliable. Students need a core of information with links they can rely on. This data must be available, quickly accessible, and consistent (not subject to moving sites and wrong URLs).

In the current implementation, all students have access to a CD-ROM that contains a repository of core information. This includes hundreds of lateral maps, textual material, photographs, and video and audio segments. This gives students offline and immediate access to a concentrated source of material. The CD-ROM is accessed through the same Web browser and html site as the Web-only Digital Agora. This means that the CD-ROM can be used on or offline with the same interface. When the student uses the Digital Agora in online mode, the use of the CD-ROM is transparent. Much of the data on the CD-ROM contains links to data in external sites.

A final requirement for success on the Web is the development of navigational aids, such as maps and fisheye views, among others. Participants require navigational aids that can be invoked at many levels: individual, group, class, concept, and global. These aids must be manipulable, storable, and shareable.

Summary

The Digital Agora is an example of a large interdisciplinary, institutional project for the support of active learning in the social sciences that has been implemented primarily as a Web-based system. Not only are the data and the users dispersed among many sites, but there is also a huge amount of data available. The Web is a natural medium for this project, as the participants are from a wide variety of backgrounds and a range of participation activities are supported, from simple browsing to the collaborative generation of new analyses.

Students at Acadia University are currently using the Digital Agora as the major resource in three different political science courses. Evaluations are planned during the year to measure the effectiveness of this tool in enhancing critical thinking and analysis of complex problems in an open and collaborative environment.

While certain features of the Web are well suited to supporting an application such as the Digital Agora, the Web also has limitations. The document metaphor and simple hypertext links are well suited for accessing repository components, although access to video and audio components is not as satisfactory as CD-ROM access. Simulations, discussion groups, shared work documents, and visual spaces are components that come with the Web browsers. Searching for related sites by keyword is easy (but frustrating), while searching for visual matches remains problematic (both on and off the Web).

Several problem areas remain to be solved in the successful deployment of the Digital Agora as a cooperative learning environment on the Web: collaborative lateral map construction, typed hypertext links, node and link authorship by readers, and navigational aids.

In summary, the Digital Agora is a good example of the next wave of educational support, which moves beyond providing access to more information to providing support for the process of engaging in the solution of complex problems as a collaborative endeavor. The use of the Web as the backbone for this project exploits the new mobility of students with laptops and allows the integration of classroom exploration with off-campus collaboration and discussions.

References


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