Integrating Geographic Information Systems into Undergraduate Environmental Science Curriculum

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Geographic Information Systems (GIS) computer programs are powerful tools for spatial data analysis and mapping that are widely used by environmental professionals. Specific GIS curricula, however, are not available for undergraduate environmental studies.

The goal of this project is to design, develop, and test an integrated set of core environmental science modules, incorporating GIS and related technologies. All components, lecture, laboratory, and field, are linked through the GIS in a multimedia framework.

Faculty design modules for a set of core courses in an interdisciplinary setting. Advanced students are involved in developing, testing, and implementing the new modules as teaching assistants in the core courses. Modules emphasize self-paced instruction, collaborative learning, group learning, and student-initiated projects. There are plans to assess the pedagogical effect of the integrated strategy. The student mentoring and alternative instructional strategies to be incorporated into the core curriculum are expected to make the Environmental Studies program more attractive to women and minority students.

The revised curriculum represents a significantly improved education practice for undergraduate environmental studies students, other science majors and non-science majors. Study of fundamental scientific concepts is integrated with study of management, decisionmaking, and ethics in a technically sophisticated framework. The project demonstrates how GIS can enhance problem solving, critical thinking and communication skills.

Nationally, this project can serve as a model for environmental science. There are plans to produce sets of interactive courseware and manuals that other programs can adapt to their own curricula. These will be disseminated electronically and through publications and workshops. Because the course materials will conform to a national consensus curriculum, other institutions should be able to incorporate them with minimal modifications.

A Laboratory Curriculum for Physical Anthropology on CD-ROM

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This project expands and extends the reach of physical anthropology by developing a first- and second-year curriculum for use at other institutions nationally. The laboratories build on current course offerings and provide materials mastered by undergraduates as stand-alone modules on CD-ROM. These electronic laboratories permit students to work on specific problems using high resolution color images, video clips, three-dimensional animations, and sound. It is also

expected that the CD-ROM will provide these materials in an easily affordable instructional medium.

Networked Financial Simulation Using LambdaMOO Technology

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Given recent advances in network and MUD (Multi-User Domain) technology, it is now possible to build a networked simulation of the international financial system containing within it several simulated national financial systems. This project involves building a simulation called Money MOO.

Few current financial or economic simulations illustrate interactions inside the financial system as a whole. Fewer still combine national and international financial systems to illustrate their interconnectedness. Although the economic system itself is dependent on interactions among individuals and institutions, currently available simulations do not typically base their outcomes on that reality. Instead, most existing financial simulation software is designed to be used by an individual student working in isolation, not cooperating or interacting with other students.

Money MOO has the following characteristics: (1) The simulation is interactive and its outcomes depend on the combined decisions of the student-players. (2) The simulation is freely available to all educational institutions through the Internet. (3) The simulation is fun to play; it is a version of the most popular networked interactive game format which exists, the Internet MUD.

This networked simulation tool permits courses such as Introductory Macroeconomics, Money and Banking, and Financial Institutions and Markets to be taught much more effectively than they can be when the only available tools are textbooks and single-user simulations.

A Multidimensional Computer-Assisted Course for Teaching the Fundamentals of Ethnographic Field Research Methods in a Laboratory Environment to Undergraduates in Anthropology

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Cultural anthropology is grounded in field research. Most undergraduates never get the opportunity to explore the relationship between ethnographic theory and field methods by applying research methods in a field environment. This project addresses these limitations by developing an undergraduate course that combines classroom-based instruction and computer-based field research simulators used in a computer laboratory. The simulators complement lectures, readings, and a course handbook that guides students through the lesson objectives. These materials are integrated into a year-long course on scientific field data collection methods and analysis and their relationship to ethnographic theory. The project further develops interactive computer simulators

(a prototype has been developed) to recreate key aspects of the field research experience in actual peasant communities. These simulators allow undergraduates to "do" fieldwork, use theory as a framework for field research, analyze their own data, and manage limited resources in an interactive research environment. Nine hypermedia interactive modules are planned, each focusing on a significant research area. In navigating a module, students are constrained by the same concerns as an anthropologist in the field, e.g., budgeting of time and limited resources, formulating hypotheses to be tested, deciding who is a reliable and representative informant, and dealing with inconsistencies in reports of informants. Decisions made at each choice point affect the data collected. Development of curricular materials and simulators includes peer review and extensive consultation with technical experts available on campus to the PI. The materials are scheduled for extensive off-campus evaluation. The impact of this project is twofold: (1) scientific research methods, analysis, and theory can be taught hand-in-hand with actual field research assignments, and (2) students learn broadly applicable and transferable social scientific research skills, including the management and organization of computerized ethnographic data.

Developing Active Learning Modules on the Human Dimensions of Global Change

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The project actively involves faculty, global change scholars, and people with expertise in pedagogy in the development of introductory-level, activity-based course modules on the human dimensions of global environmental change and establishes a process within the Association of American Geographers (AAG) for the development, evaluation, and dissemination of these and other active-learning modules of introductory courses. The first goal addresses the needs to infuse recent global change scholarship into the introductory undergraduate curriculum, and it actively involves students in the learning process. The second goal seeks to address the current absence of any formal mechanism within the discipline of geography for the sharing of teaching and learning resources among undergraduate instructors. The principal expected outcomes are modules that speak to the three broad components of global environmental change: (1) the human and physical causes or driving forces of change; (2) the environmental consequences produced by these forces; and (3) the human responses to these environmental consequences. Central to these modules are the concepts of how human causes, environmental impacts, and human response vary by location (geographic area), and how the relationships among components are affected by the spatial and temporal scales of analysis (local, regional, global; decadal, centennial, millennial respectively). The project also establishes a clearinghouse within the AAG to disseminate the modules for use in introductory courses nationwide. The modules will be available to all instructors of some 500,000 students who are enrolled in introductory geography courses annually. Once this project is completed, the AAG clearinghouse will continue to develop and disseminate activity-based undergraduate learning materials.

Project on the Language-Art Interface: Vision and Voice—-Rethinking Human Communication

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The Project on the Language-Art Interface (PROLARTI) focuses on the development of a prototype of a CD ROM, with the title: "The Origins of Communication," the first part of a three-part series titled: "Vision and Voice: Rethinking Human Communication." Designed for use by undergraduates in introductory level courses (in both traditional and long-distance classroom and home settings), "Vision and Voice" aims to encourage the exploration of language within an interactive, multimedia, interdisciplinary and cross-cultural environment. It links together the methods, theories and data of anthropology, biology, cognitive science, linguistics, literature, neurology and the visual and performing arts. In both its prototype and future CD-ROM formats, "The Origins of Communication" focuses on three broad areas of language: (1) Evolution; (2) Human Development, Language Acquisition, and Animal Communication; and (3) the Brain. All three areas of investigation include multidisciplinary material (theories, data, controversies) on visual and verbal aspects of communication. It is PROLARTI's first undertaking, which promises to provide a model for truly interdisciplinary research and teaching on language and to bridge the widening gap between the sciences and humanities. It plans to do so by redesigning scientific investigations of human communication to include the study of art alongside the study of language. When art is defined as "visual representation," its presence in all aspects of human communication (e.g., gesture) becomes apparent. Rather than simply emphasize similarities between language and art, PROLARTI's prototype for "The Origins of Communication" will focus on their differences as well. Language, being primarily a symbolic system of signs, stands in contrast to iconically-based systems, such as art. The shift in emphasis as exemplified by PROLARTI's prototype of "The Origins of Communication" aims to not only broaden the study of language to include all communicative processes—nonverbal forms (glossed here as "art") as well as verbal—but to expand the teaching of undergraduate courses on language by incorporating multimedia and interactive material from the life and social sciences as well as the humanities.

Quantitative and Experimental Modules for Undergraduate Education in the Human Sciences

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Undergraduate science education has two jobs. First it must prepare young scientists to continue their studies in one of the disciplines. But even more important, science education has a responsibility to the Nation to ensure scientific literacy. This project involves undertaking a constructivist introductory program that lets students study quantitative and experimental aspects of human nature from the biological to the social at varying depths and breadth. The educational design consists of transportable but interdependent modules, each developed in collaboration with a nationally recognized researcher in the field, that require careful reading and analysis, occasionally of primary sources. There are also opportunities for a variety of complementary projects, field trips, computerized experiments and simulations, and summer studies in research laboratories that

let students extend their science skills. Some of the CAI programming has been completed, and computer-based evaluation is in development. Novel testing techniques have been vetted in the pilot work and are being refined and extended. These evaluation methods test both students and the materials and serve to guide revisions and extensions of the modules. This model for teaching science is centered on subject matter of intense personal interest and delivered in a way that is at once serious, exciting, hands-on, and technically advanced. The modules use lectures, peer discussion, demonstrations, field work, and experimentation to teach the methods and results of science. Three modules have been completed and taught: two in biology and one in psychophysics. An extended assessment supports the effectiveness of the completed and tested units, in particular with minority and women students. The materials, when complete, will not only enhance science literacy in general, but will also permit admission to majors programs in biology, psychology or the social sciences. Portability and intermixture with traditional materials allow their use, individually or collectively, in a variety of venues. Student participation in the collection and analysis of data and concepts are central to most modules, thus departing significantly from audio-visual and electronic augmentations of classical lecture methods. These separable, but cross-integrated, units can be adapted to a variety of teaching contexts. This portability will be demonstrated by testing them at neighboring institutions during or immediately following this grant. Publication of the modular packages is currently being explored, possibly as separate units.

Introductory Microeconomics: The Way We Live

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Economics teaches a way of thinking, "an ability to assess alternative choices in the face of constraints," that is fundamental to informed private and social choice. There is virtual consensus that an effective introductory economics course should teach students how to think intelligently and independently about economic issues. Yet, evidence suggests that the education community falls far short of this goal due to the increasingly encyclopedic and abstract nature of the material and a failure to respond to the experiences of an increasingly diverse student population. Moreover, the social and economic impact of increasing global interdependence is often ignored.

This project is developing an introductory microeconomics course that focuses specifically on the economic decisions that individuals make over the course of their lives. "Introductory Microeconomics: The Way We Live" introduces economic concepts and analytical tools within the context of specific choices students face, such as the decision to get married or obtain a college education. Creating these connections between new information and personal experiences provides a strong motivation for learning. In addition, the course integrates exercises on numeracy and computer analysis, thereby providing an active, hands-on learning environment. The project can significantly enhance students' economic literacy, numeracy, and appreciation for cultural diversity by incorporating up-to-date data for such purposes as international comparisons.