

Learner-Centered Education Program
Arizona Board of Regents
INSTITUTIONAL SUPPORT FORM

**The Virtual Environmental Learning Space
Phase III: Building an Online Learning Community**

Proposal Title:

Institution: NAU DEPT/Unit: Computer Science & MPCER

Multi-Campus/University Projects

List other participating agencies: (check other campuses or universities participating)

ASU Main UA

ASU East UA South

ASU West X NAU

Briefly describe the program and the development plan.

We propose to build a Virtual Electronic Learning Space (VELS) that will move ecological science education at NAU into the 21st century by greatly enhancing learning experiences, exploring a novel integration of the research and learning communities, and promoting the development of interdisciplinary course content.

Funding Category

Indicate a primary (P) and, if applicable, secondary (S) funding category:

Professional Development _____ Program or Course Development/Modification _P_____

LCE Research _____ Improved Assessment of Learning Outcomes

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The Virtual Environmental Learning Space

Phase III: Building an Online Learning Community

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Abstract

Two years ago, we pioneered a novel pedagogical model for teaching ecology called the Virtual Environmental Learning Space (VELS), which explores a compelling integration of research and learning communities and promotes the development of interdisciplinary course content. Our goal is to create an ecological “explore-atory”, an interactive on-line system that weaves together course curricular modules, actual research datasets from ongoing ecological research projects, and novel “virtual explorations” of different climatic zones to create engaging and highly relevant learning experiences. Some VELS components are tailored to specific courses, guiding students’ explorations and investigations with structured laboratory modules; other components promote more free-form exploration, enabling students to make connections among fields and courses.

At this point, we have developed (with funds from a partially funded LCE 2004 proposal and NAU E-learning grant in 2002-2003) a core VELS technological infrastructure, developed several course modules, and piloted the system in several smaller biology/ecology courses. Based on the enthusiastic feedback from this pilot experience and the lesson learned, we now propose to develop new course modules to extend the VELS experience to large enrollment introductory courses, and to add additional data visualization tools, interactive student forums, and more complete linkages with the Southwest Ecological Research Forum (SERF). Leveraging our complementary development of SERF provides us with an unprecedented opportunity to explore a novel concept in integration of research and teaching, by allowing students to inspect, analyze, and learn from ongoing research projects. Essentially, students will be able to electronically “look over the shoulder” of active researchers to observe how science works. Novel and creative learning environments like VELS represent precisely the leadership in environmental and ecological research and education that NAU strives to provide.

1.0 Identification of Need

Study of the natural sciences - including ecology, biology, geography, forestry, and environmental studies – is necessarily a study of the interconnected systems that make up our natural world. The study of a natural organism or phenomenon cannot be effectively addressed in isolation; learners must have access to the environmental context that the organism or phenomenon inhabits. Traditional natural sciences education, however, is not able to provide this immersive experience. Students are expected to understand complex natural systems based on textbook descriptions; laboratory exploration is limited to toy problems on toy datasets, and further sterilized by a host of simplifying assumptions.

The VELS project provides a visionary alternative that leverages advances in multimedia, network, and online learning technologies to provide students with an immersive, intellectual experience in science learning. Using VELS, students in the natural sciences will be able to virtually “visit” various study sites across a range of climatic zones, access real biological, ecological and environmental data collected at those sites, and use sophisticated GIS and graphical analysis tools to explore and visualize the relationships between the many factors – soil type, rainfall, elevation, vegetation types, and so on – that shape a complex ecological system. In this Virtual Environmental Learning Space, populated by real data collection sites, real data, and real in-progress studies, students are presented with a highly realistic, engaging learning experience that can’t be matched by any textbook or conventional laboratory exercise. Guided by structured curricular modules, they will be led to (re)discover basic ecological relationships but also, via access to a rich variety of actual environmental data, will be able to explore on their own, to bump up against some of the open questions that motivate research in the natural sciences.

Throughout this process, they will be connected with other learners, both from their own course, and from other courses that are using the VELS from different perspectives. Such connections will be supported in VELS via discussion forums (similar to newsgroups) associated with key topics, and well as with specific studies, datasets, or collection sites represented in VELS. Students or groups of students may also “link up” to jointly browse the VELS site, collaboratively viewing and discussing data and analytic visualizations. In this way, the online learning experience is transformed from a solo exploration into a dynamic journey

through a living space populated by scientists, other learners, and a growing body of insights and commentary from both. This core VELs vision of a dynamic learning process driven by empowered learners directly reflects the Learner-Centered Education ideals promoted by Alan Guskin and others. Specific pedagogical improvements offered by VELs include:

De-compartmentalized learning – erase intra- and interdisciplinary boundaries; make connections between various natural science courses, ecological perspectives, and environmental/social issues.

Experimental learning – increase student motivation; promote interaction between students and between faculty and students.

Improve understanding of field science, quantitative techniques and environmental issues across the curriculum.

Allow students to develop skills in online technologies useful in many areas of business and academia.

During development of the current, limited VELs prototype, we have engaged or received inquiries from faculty in Biology, Environmental Sciences, Quaternary Studies, and Political Science; we expect this list to grow in future as other units across campus and beyond draw on this educational resource. The future and growth of VELs will be directed by our assessment and evaluation plans that include student work, student evaluations, and faculty evaluations; the first of these evaluation cycles is occurring in October 2004, as students complete VELs pedagogical modules being piloted in three biology and ecology courses this fall.

2.0 The Virtual Environmental Learning Space (VELs) System

The VELs system (<http://denali.cse.nau.edu/orfs/vels/forum.php>) consists of a secure, web-accessible online learning space that allows both on-campus and remotely participating students to interact in “virtual learning communities” centered around individual NAU biology and ecology courses. Students interact with VELs via a growing set of “course modules” which are developed in close participation with course instructors, and which encapsulate specific course content and analytic laboratory exercises. Although module content varies widely (being tailored to specific courses), the general theme is that modules encapsulate “structured research experiences” in which students exercise a variety of data collection and analysis skills within the context of a realistic research challenge, e.g., analyzing patterns of invasive species penetration in a particular area. Students are able to upload their own datasets to VELs, then use VELs analytic tools not only to visualize and analyze that data, but also to cross-compare and contrast their data with actual research datasets being produced by ongoing ecological research projects and NAU and elsewhere on the Colorado Plateau. This latter capability, representing a novel and compelling integration of pedagogy with research – is made possible by the tight integration of VELs with the Southwest Ecological Research Forum (SERF), an online research informatics site that we are constructing in a parallel NSF-funded effort to provide robust support for widely-distributed ecological research efforts spanning the Colorado Plateau. The SERF infrastructure provides for secure site access, control over data, data-specific discussion forums for researchers, sophisticated visualization and analysis tools, and many other features. Leveraging this development, we have adapted many of these features for use by students within VELs; by piggy-backing VELs development onto the core SERF infrastructure, we avoid redundant creation of a similar substrate, and can focus our efforts on VELs extensions and course modules. Moreover, integrating VELs and SERF will allow us to seamlessly incorporate learner access into an active research environment: course module lessons can be based on actual research datasets, students can use sophisticated SERF analytic tools and access the extensive community database of researcher, lab, and publication data. Within certain constraints, students may even observe active ecological research projects that are generating

SERF data. Figure 1 provides a graphical overview of VELs and its relation to SERF.

Figure 1: VELs is a complementary, teaching-oriented counterpart to the SERF research forum, embedding SERF data and analytic tools within a rich variety of structured learning experiences. On-campus and remote students may participate in the same courses; project teams may span several disciplines/courses.

As indicated in Figure 1, VELs leverages the SERF infrastructure – including authentication and security mechanisms, online data archives, analysis and visualization tools, and discussion forums – but makes these resources relevant and accessible to learners by embedding them in a rich variety of structured learning experiences. Essentially, VELs provides a pedagogically-oriented interface to the complex research

resources provided by SERF, allowing students to work on real data, investigate real problems, and have contact with real research, while at the same time modulating the complexity of the research environment. In this way, VELs places students in the role of apprentices, or “junior scientists”; this sort of hands-on involvement lies at the core of the learner-centered teaching philosophy.

2.1 Past Progress and Current Status of VELs Development

We have developed various components of the above VELs vision over the past two years under an NSF Course Curriculum Improvement grant (DUE-0088626), an internal NAU E-learning development grant (Fall 2002), and an initial LCE grant (Fall 2003). Under last year’s LCE project funding, we performed the core integration of VELs into the existing SERF infrastructure described in the previous section; this formed the cornerstone for the VELs system, allowing VELs pedagogic modules to access the actual research datasets in SERF. Specific accomplishments include:

- 1 Development of six pilot VELs pedagogical modules that draw on the MPCER Elevation Gradient, a growing research dataset of weather and climate data on and around the San Francisco Peaks.
- 2 Development of “Class”, “Student/Instructor”, and “Module” as logical elements within the existing SERF informatics infrastructure, including mechanisms for logging in as either a student or instructor of a course. Students may download weather data, upload new datasets for analysis and comparison to research datasets; instructors may upload course data and check student progress.
- 3 Development of a variety of proof-of-concept online analytical and data visualization tools both suitable and compelling for student use, including a virtual reality tour (http://mprlsrvr1.bio.nau.edu/vr_tour_desert.htm) of the five elevation gradient sites; a fly over (mms://mprlsrvr1.bio.nau.edu/fly_by_full.asf) of the area of the elevation gradient (including the San Francisco Peaks) showing the terrain and vegetation of the area in a broader geographic context; and an map server which let students easily navigate maps of the elevation, vegetation, soil, land ownership, roads, and elevation gradient field site locations (http://mprlsrvr1.bio.nau.edu/Atlas/Gradient_Atlas_HTML/default.htm).
- 4 Pilot deployment of the nascent VELs infrastructure and the six new modules in support of three courses offered in Fall 2004: Bio326, Env230, and Env110. The initial response to the deployment of the VELs prototype has been extremely encouraging. Instructors have been impressed by the ease of VELs class set-up and maintenance; informal feedback indicates that students are stimulated and highly-motivated by the opportunity to take the data they have collected during course lab segments, and compare or juxtapose it with existing research datasets accessible via VELs. We are currently collecting formal student feedback to inform our further development of VELs via two mechanisms: a “Questions and Comments” link that appears on all VELs screens, and a confidential online course survey and evaluation tool linked to each VELs module/course. Results of these evaluations are not yet available (students are not yet finished with VELs segments of the three courses), but will be available by late October 2004.

3.0 Specific Tasks to be addressed under requested funding

Although the core VELs infrastructure is in place and several modules have been deployed, much remains to be done. In particular, our aim now is to focus on (a) expanding VELs support to more students and courses and

(b) replacing the rudimentary analytic tools available in VELs with more powerful and compelling (to undergraduates) graphical analysis and visualization tools, and (c) seaming all of these components together into a vibrant online learning community. The latter aim is especially vital. As it stands, students log into and interact with VELs as individuals. A key element of the VELs vision, however, is to support joint exploration between students, and robust learner-learner interactions within and between courses and disciplines using VELs. To meet this need, we propose to add “data-connected discussion forums” (see Section 1 for detailed description), which may be “attached” to any VELs dataset or course. In sum, our goal is to realize VELs as a virtual learning forum that provides support for interdisciplinary teaming, student-student learning interactions, data-centered critical discussions, a complementary integration of learning and research activities, and support for both traditional on-campus and remote (distance) participation.

Specifically, we propose to complete the following specific development activities under this funding:

Develop additional VELs course modules to reach at least 200 more students/year. Add resources for additional large enrollment classes and classes concerned with environmental issues from across campus.

Design and implement data-connected student discussion forums; explore mechanisms for allowing forums to span and be cross-indexed by multiple classes across the disciplinary spectrum.

Continue VELS integration with SERF by cross-linking course module contents to SERF resources like the publication database, and data on labs, researchers, and currently active studies.

Extended data analysis and visualization. Develop a simplified GIS-based tool for juxtaposing student-collected and SERF datasets ecological data onto dynamic terrain maps. Improve fly-over animations by adding additional geospatial information and possibly adding interactivity.

Add a secure online grading system for the convenience of students and instructors so that more time can be spent focused on learning.

Respond to assessments of last year's efforts with refinements of current VELS modules and functionality.

Although we expect to make tremendous progress towards a complete VELS system under this interdisciplinary development effort, new challenges and pedagogical possibilities will materialize as the project progresses. We will continue to pursue additional funding to address these extensions, as we work to bring the VELS vision to full potential.

4.0 Technical Needs

Both MPCER and CCL (Collaborative Computing Lab; Doerry lab in Computer Science) have extensive resources that will be made available to developers. MPCER will provide: a Dell 2600 Server, network attached storage space and a modern workstation for developer Heinrich, equipped with a full complement of software including ARCGIS, ARCIMS, Photoshop, and a variety of other multimedia creation tools. CCL will provide: Dell Pentium4 development station for developer Nassar equipped with CVS, Schema Architect (DB design), and other software development tools, as well as multimedia development resources; a secure Debian Linux web/DB server to support the VELS site, including Postgres DB, PHP support, and a secure web server. In addition, the CCL usability lab will serve to validate usability of the resulting prototypes.

5.0 Work Plan and Key Personnel Overall distribution of duties:

Dr. Eck Doerry is Associate Professor of Computer Science and an expert on on-line communities. Will supervise Karim Nassar, provide overall technical leadership, and will lead a participatory design effort to create a usable interface and toolset for VELS, 2.5% time.

Karim Nassar, Programmer, will be the technical lead on the SERF integration, database programming, and creation of the core VELS site infrastructure.

Dr. Neil Cobb, Associate Director of MPCER, will supervise Paul Heinrich, 2.5% time.

Dr. Amy Whipple, Program Director of MPCER, will recruit faculty into the project and review content produced, 2.5% time.

Paul Heinrich, MPCER system administrator and web master, will develop website, multimedia elements, and work with faculty to develop modules. Faculty from Biology, Environmental Science, Geology, Anthropology, Forestry, Political Science, and Electrical Engineering have expressed interest in having their courses use VELS.

Timeline: April 2005: Collect pre-VELS assessment data on a course which will be adding a VELS module (e.g BIO 100 or 182). Make adjustment to VELS based on the assessments of last years efforts. May 2005-July 2006: a) develop module content with faculty and b) do computer programming for: student discussion forms, improved data uploader, publications database, visualization tools, and cross-course browsing/information retrieval. August 2005: Faculty review of site and modules and responses. September-November 2005: module/student assessment and refinement. Implement online grading systems and ability for students to add their data to online mapping resources. December 2005-January 2006: final assessment of project. February-March 2006: refinements in response to assessment.

6.0 Expected Results and Outcomes

Please see the work plan timeline for the time of completion of concrete steps in VELS development. Here we elaborate on the levels of use and progress in student learning we expect to achieve. Statistics to be collected include: 1) Modules using the VELS forum by the end of the program (goal of 10). 2) Students using the VELS forum by the end of the program (goal of 500). 3) We will also monitor numbers of viewings, searches, and exchanges to assess what about the site is working and not working.

Assessments will include faculty assessment of utility of VELS, online comment mechanisms for student assessment of the resource, and assessment of learning outcomes. For one course we will conduct assessment of student learning outcomes before and after VELS modules have been integrated into the course. In all courses we expect to foster technological literacy and understanding of the environment, environmental sciences, and quantitative methods through providing information resources in an

engaging manner. We will use papers, oral presentations, and laboratory reports that relate to the VELS as assessments of student learning because, although there will be factual information on the website, the real goals are to promote the understanding of how to use and interpret those facts. We expect students who use the VELS system to show greater improvement in learning goals appropriate to the course they are in. Learning goals include: 1) Understanding of the scientific method. 2) Understanding methods and technology in environmental sciences. 3) Informed discussion of environmental issues. 4) Understanding the utility and limitations of statistics. 5) Learning to use the web to share data and manuscripts (posting and receiving). 6) Learning to analyze data. 7) Learning to display data to convey the main point.

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LCE Research Improved Assessment of Learning Outcomes

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