

# Learner-Centered Education Program

Arizona Board of Regents

## INSTITUTIONAL SUPPORT FORM

### The Virtual Environmental Learning Space: Phase II

Proposal Title: \_\_\_\_\_

Institution: NAU DEPT/Unit: Computer Science & MPCER

Multi-Campus/University Projects  
(check other campuses or universities  
participating)

List other participating agencies:

\_\_\_ ASU Main

\_\_\_ UA

\_\_\_ ASU East

\_\_\_ UA South

\_\_\_ ASU West

\_\_\_ 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 21<sup>st</sup> 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 \_\_\_\_\_

#### Authorizations

#### Project Director:

Signature: \_\_\_\_\_

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#### Department Chair / Unit Director/ College Dean/Provost

Name: John Placer Title: Chair

#### Signature

#### Official Authorized to Enter into Contractual Obligations

Signature \_\_\_\_\_

Name: \_\_\_\_\_ Title: \_\_\_\_\_

Phone: \_\_\_\_\_ Fax: \_\_\_\_\_ Email: \_\_\_\_\_

Phone: 602-229-2500 • Fax: 602-229-2555

Learner-Centered Education Grant Program

Arizona Board of Regents

# The Virtual Environmental Learning Space (VELS)

## Abstract

We propose to build a Virtual Electronic Learning Space (VELS) that will greatly enhance ecological science education at NAU by creating an engaging online learning environment that explores a novel 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 data from ongoing ecological research projects, and novel “virtual explorations” of different climatic zones to create engaging and highly relevant learning experiences. Some VELS components will be tailored to specific courses, guiding students’ explorations and investigations with structured laboratory modules; other components will promote more free-form exploration, enabling students to make connections among fields and courses.

To accomplish this, we propose to build on our successful pilot efforts (funded under an NAU E-learning grant in 2002-2003), by developing new course modules, prototyping additional data visualization tools, and integrating all VELS components into the nascent Southwest Ecological Research Forum (SERF), an on-line research forum which is being constructed in parallel under NSF funding, and which will form the informatics cornerstone for ecological research on the Colorado Plateau. Leveraging this complementary development (the construction 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.

### 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 with specific studies, datasets, or collection sites represented in VELS. Students or groups of students may also “link up” to jointly browse (each at his or her own computer/browser) 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.

We have already engaged faculty and their courses from 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. We have demonstrated commitment to the long-term continuation of the VELs initiative through the active development of the MPCER gradient website. The future and growth of VELs will be directed by our assessment and evaluation plans that include student work, student evaluations, and faculty evaluations.

### **Development of the VELs**

The VELs system will consist of a secure, web-accessible online learning space. Within this space, students will have access to a wide variety of resources associated with the C. Hart Merriam Elevation Gradient (MEG; <http://www.mpcer.nau.edu/gradient/>), including remote monitoring sites and equipment, special course modules, climatic data, and reference and training resources. We have begun developing all of these resources under an NSF Course Curriculum Improvement grant (DUE-0088626) and an internal NAU E-learning development grant awarded in Fall 2002. Specifically, we have developed four course modules, a “virtual field site” that provides access to a remote data collection site, and a growing collection of environmental datasets extracted from the MEG. What is missing, however, is comprehensive metaphor for integrating these varied resources within a secure, web-accessible environment – a virtual learning space. *We envision a virtual 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.*

In order to meet this ambitious vision within the funding and timeframe of this proposal, we propose to leverage the robust infrastructure of the Southwest Ecological Research Forum (SERF), an online research informatics site that we are constructing in a parallel NSF-funded effort. The SERF infrastructure will provide for secure site access, control over data, data-specific discussion forums for researchers, sophisticated visualization and analysis tools, and many other features. Many of these features could, with modest effort, be adapted for use by students within VELs as well. 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 into 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 eco-science research projects that are generating SERF data. Figure 1 provides a graphical overview of VELs and its relation to SERF.

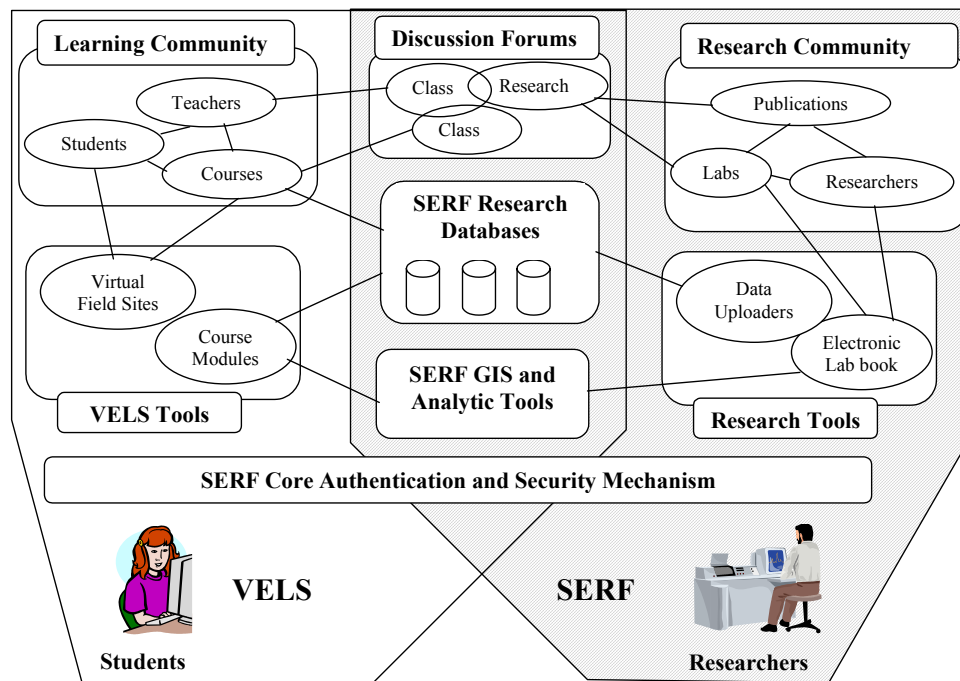


Figure 1: VELs as a complementary, teaching-oriented counterpart to the SERF research forum. VELs draws on SERF infrastructure, data, and analytic tools, embedding these resources within a rich variety of structured learning experiences and course modules. On-campus and remote students may participate 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.

### Background on the SERF project\*

Before detailing the specialized VELs components we propose to construct under this grant, it is necessary to outline the basics of the SERF system. The SERF system is what we call an *Online Research Forum (ORF)*, a novel concept that extends the digital library metaphor to create a comprehensive virtual research community embedded in a rich interconnection of community member information (researchers, labs, publications) and research resources (sophisticated database search mechanisms, integrated statistical analysis and graphing tools, species lists, and GIS visualization tools) with continually updated and growing research datasets. Support for online commentary and critical discussion forums attached to specific datasets, data types, and projects make SERF not only a central clearinghouse for data, but also a “place” for the ecological research community to meet, engage in critical discussion, collaboratively analyze datasets, and otherwise interact. Because users are authenticated as registered members of the community, SERF is able to control access to SERF data and resources, and to provide individually customized views of SERF to each user. Individual datasets are hotlinked to information on the originating data source, the associated project, labs, and researchers, to other datasets of the same data type, and so on. Researchers are able to upload and analyze new datasets immediately as they are generated by their field experiments, releasing these datasets for public inspection when appropriate.

Over Spring 2003, we developed a prototype for the SERF system under the name “Merriam-Powell Online Research Groups” (MPORG; [denali.cet.nau.edu/MPORG](http://denali.cet.nau.edu/MPORG)), which applies the SERF concept to limited climatic data on the Colorado Plateau; we are actively developing the full implementation of SERF, which will support a wide variety of inter-linked data types, as well as a suite of analytic tools.

\* For details on the SERF project, see <http://denali.cet.nau.edu/SERF/>.

### Specific Tasks addressed under this funding

We propose to (a) develop additional VELs components, extending and complementing those developed under previous funding and (b) integrate all VELs components into the core SERF architecture. Specific tasks include:

- Develop six additional VELs course modules; with existing modules, this brings the total to ten, which will cover many core natural science courses.
- Extend the core SERF database schema to integrate data entities to represent “students”, “faculty”, “courses”, and to represent and enforce the relationships between them.
- Integrate all VELs course modules into the SERF system, allowing modules to draw on archived data, and to cross-link course module contents to SERF resources like publication data, and data on labs, researchers, and studies.
- Extend SERF to allow students to upload their own datasets generated by their own field studies done as course-related lab activities. A comprehensive data model for student data will be collaboratively developed by representative faculty.
- Develop a simplified GIS-based tool for mapping ecological data onto terrain maps.
- Design and implement student discussion forums; explore mechanisms for allowing forums to span and be cross-indexed by multiple classes across the disciplinary spectrum.
- Add resources for additional large enrollment classes and classes concerned with environmental issues from across campus.

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.

### 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 the following software: World Construction Set (for animated landscapes), ArcGIS (for GIS development), ArcIMS (for serving GIS data over the WWW), Adobe Photoshop (graphics), After Effects (animation), Premiere (video editing), Macromedia Studio MX (website and graphics), Lightwave 3D (3D graphics), PTGUI (SVR development), Endnote (bibliography) and Microsoft Office.

CCL will provide: Dell Pentium4 development station for developer Nassar equipped with CVS, Schema Architect (DB design), and other software development environments, as well as Adobe Photoshop and Premier, graphics tablets, cameras and other multimedia development resources; a secure Debian Linux web/DB server to support the VELs site, including Postgres DB, PHP support, and numerous other software. In addition, the CCL usability lab will serve to validate usability of the resulting prototypes.

### Work Plan and Key Personnel

#### Overall distribution of duties:

- Dr. Eck Doerry is Assistant Professor of Computer Science and an expert in on-line communities. He will supervise Karim Nassar, provide overall technical leadership, and will lead a participatory design effort (with students and faculty) to create a usable interface and toolset for VELs, 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 database content.
- Dr. Mario Montes-Helu, Postdoctoral Researcher, will maintain the C. Hart Merriam Elevation Gradient weather stations, 5% time.

Faculty from Biology, Environmental Science, Geology, Anthropology, Forestry, Political Science, and Electrical Engineering have expressed interest in having their courses use VELs.

#### Timeline:

**January 2004** initiate project. **March 2004** complete VELs on-line forum prototype, modules for two additional courses, and compiling of reference resources. **May 2004** Complete the elevation gradient fly overs showing the

potential effects of changing climate on the landscape, integration of existing web resources into the on-line forum, and student data entry and collection policies. **June-July 2004** test and run pre-release evaluations of online forum using a test class. **August 2004** respond to initial testing and evaluation with revisions to the VELS system and enhance virtual tours of the field sites; release discussion forum extensions. **October 2004** add modules for two more courses. **December 2004** fully integrate GIS resources with classes and data on VELS. **January 2005** conduct annual update of bibliographic resources. **March 2005** add modules for two more classes and evaluate responses to faculty and student assessments. **May 2005** complete updates and revisions to VELS as directed by assessments.

### **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) Courses 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 400). 3) We will also monitor numbers of VELS logins, viewings, searches, and exchanges to assess what aspects of the site are 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. Evaluations will explore the following issues: 1) Was the VELS system easy to use? 2) Were course module materials relevant and well-matched to course content? 3) Did VELS help students better understand the targeted course concepts and skills? 4) What features of VELS did users use/like the most? 5) What VELS tools or features would users like to see added?

For two courses, we will do assessment of student learning outcomes before and after VELS modules have been integrated into the course. Learning outcomes and assessment will vary from course to 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 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.

## Detailed Budget

- I. Budget Request: Our budget request consists of part-time salary for two part-time staff who have worked on the previous phases of this project. (\$49,041)
  - a. 35% time for Paul Heinrich who is the web content developer. He has an MS in Ecology and experience in computer support and web/digital video educational development. \$23,912 for 18 months salary and benefits.
  - b. 35% time for Karim Nassar who has a BS in Computer Science and experience in programming for web delivery of data. \$25,129 for 18 months salary and benefits.
  
- II. Match: \$36,998 plus
  - a. Overhead on salary request for Karim Nassar and Paul Heinrich: \$18,916.
  - b. VELS server purchased for the project on an internal NAU e-learning grant (prop 301): \$4,911.
  - c. Additional faculty and staff time: Dr. Eck Doerry 5% academic year (\$5,082), Dr. Neil Cobb 2.5% (\$2,406), Dr. Amy Whipple 2.5% (\$1,832), and Dr. Mario Montes-Helu 5% (\$3,850). (Indirects not included.)
  - d. Additional MPCER and Doerry computer lab equipment and software will be used for this project as well, but have not been itemized because we exceed to need match.
  
- III. Future funding: This funding request will enable a large leap in the functionality of VELS and its level of use. However, it will not allow us to complete our full vision. This funding will leave us well placed to apply to NSF computer science and education programs for additional funding.