

# **Mapping, Analyzing and Problem Solving Using Geographic Information Science: Implementing a GIS Curriculum for Technical Literacy**

Lane Community College, Eugene, OR

## **Project Description**

### **Motivating Rationale: Need for a GIS Literate Workforce**

The world we live in is increasingly managed by geographic information systems. When we call the electrical utility about a power outage, a connected network finds and directs a location-specific response. When the police department shares crime-reduction data with the community, it uses geographic information science (GIS) software to provide a visual representation of crime areas. Forest ecologists determine conservation recommendations utilizing GIS analysis of vegetation types, animal habitats, and potential conservation practices. An increasing number of fields is adopting GIS to enable visual/spatial representations of data, solve spatial problems, and combine quantitative data with qualitative analysis and reporting capability. Geography educators highlight the need for GIS education: “The exponential growth of digital geographic information will continue and will generate concomitant demand for professionals at all levels, people who understand its use and foundations. Nevertheless, use of geographic information and associated technology by untrained, or even unaware, individuals will increase even more dramatically” (Brown, et. al., 2003, p.369).

Technical expertise for using GIS is needed across a wide range of social and scientific applications and covers an equally broad range of skills. Familiarity with the potential and limits of GIS for analyzing a wide-range of problems will be essential for students in STEM disciplines. In Oregon, regional planning, public utilities, human services, public safety, forestry, geosciences, and bio-resource fields all use GIS. There are two areas of need for GIS literacy and skills: (1) for highly skilled technical specialists who develop GIS data and representations; and, (2) for desktop users, who use GIS data to solve problems and display information.

Regional public and private sector GIS users need employees who are literate in GIS software and skilled in GIS applications. However, the majority of GIS end users among public and private employers is degreed personnel in disciplines, not GIS technical specialists. These workers must possess a strong conceptual understanding of GIS, spatial problems, and data allocation embedded within the application domain.

Where will tomorrow’s STEM workforce acquire the GIS literacy and skills they need? Existing GIS training at four-year universities is typically reserved for upper-level students in particular majors. At the University of Oregon, Oregon State University, Southern Oregon University, and Western Oregon University, GIS curricula are focused on 300-400G level courses, or research purposes. Oregon State University offers two lower division courses; however, one is an online software training class, the other a third-term course in a Civil Engineering sequence. At the community college level, GIS courses are tied to professional technical certificate programs or specific resource management programs. While Central Oregon, Clackamas, and Chemeketa community colleges have excellent programs, they serve a limited number of students within a self-selected group. Nationally and in Oregon, undergraduates who are still exploring their career options have few opportunities to gain literacy and entry-level skills in GIS. At Lane, students completing their transfer program in STEM disciplines and social sciences have little, if any, exposure to GIS analysis and applications; nor do they have articulated pathway to advanced GIS courses at four-year schools.

Lane Community College will implement two complementary strategies to remove obstacles to undergraduate GIS education and provide a solid foundation for further studies in GIS: (1) integrate problem-solving GIS modules in science, social science, drafting and computer science to introduce GIS literacy within disciplines that need it most; and (2) provide an efficient three-course sequence for entry-level GIS competency. The embedded GIS modules will provide first-exposure to GIS as a tool for problem solving. The MAPS GIS course sequence will provide a solid foundation for students seeking GIS training to strengthen their preparation for advanced studies and expanded job options and opportunities.

While the project directly benefits Lane, it also has the potential of **broader social, technical and intellectual impacts** among the community, other institutions of higher learning, the region, and the nation. The multi-discipline nature of GIS and embedded modules will result in technical skill development and GIS literacy for hundreds of students across disciplines. The nature of GIS, combined with MAPS collaborative, experiential, and work-based approach will improve learning and attract underrepresented students who have been intimidated by traditional STEM programs.

These impacts also have considerable **intellectual merit** in that they can transform the way GIS is utilized within many STEM disciplines and applied fields, including the social sciences, environmental science, biology, geology, computer information, law enforcement, business, among others. MAPS will remove obstacles to undergraduate GIS education and provide a solid foundation for further studies in GIS. GIS instructional modules will be embedded within a broad range of STEM courses. MAPS embedded modules will engage students in spatial problem solving and collaboration to learn both GIS principles and concepts of the primary disciplines in which GIS is normally employed. The three-course GIS sequence will provide a rigorous and work-based foundation for students to continue GIS education.

#### Recruiting underrepresented students to an accessible GIS curriculum

By embedding GIS modules in a wide range of introductory general education courses and two professional technical areas, the MAPS GIS project will introduce GIS literacy and skills to students who are underrepresented in STEM, such as women, minority students, first-in-family college students, and rural students. The modules will present work-based problems drawn from real-world scenarios, demonstrating strong social and scientific relevance. Additionally, collaborative, project-based learning activities will engage students in teamwork to foster interpersonal and organizational skills that are prized in today's workplace (Carver, Evans and Kingston, 2004; Lloyd, 2001; Summerby-Murray, 2001). Collaborative learning strategies have been shown to support the learning styles of women and other underrepresented groups in STEM. (Rutherford & Lloyd, 2001)

#### Developing a Regional Link for GIS Education and Training

Lane Community College is a comprehensive two-year public college whose mission is to provide accessible, high quality, affordable lifelong education. Lane is centrally located along the I-5 corridor between Portland and Southern Oregon, providing a link to the University of Oregon, Oregon State University, Western Oregon University, and Southern Oregon University. Lane's strength in teaching science, geography, and computer information technology and its proximity to four-year colleges uniquely position the college to take a leadership role in implementing GIS education in the region. As Oregon's second largest community college, Lane serves a mostly rural district, stretching from the Pacific coast to the crest of the Cascade Mountains, covering 5,000 square miles (approximately the size of Connecticut). In 2003-04, the college served 29,743 individuals in credit and non-credit programs (10,700 FTE). In Lane County, the Hispanic population has more than doubled between 1990 and 2000. Fifteen percent of entering credit students are people of color, which is 10 percent higher than the general Lane County population, indicating the college's success in recruiting underserved populations.

### Challenges that MAPS GIS will overcome

Currently, Lane faculty face significant hurdles for adding GIS problem-solving activities to their curricula. Few faculty have experience in using GIS and developing GIS curriculum. Developing a transfer-appropriate GIS course sequence will face many challenges. Articulating the course sequence with regional university courses will be complex because each university teaches GIS in different program areas and, for most, restricts GIS training within particular majors. Establishing the industry skill set for the courses will require the ongoing involvement of Lane's GIS Advisory Team, already formed during design of the project. The technical infrastructure to use embedded modules or teach GIS courses is not available. New servers, software tools, and equipment upgrades to existing computer laboratory space are required for the demands of GIS.

### **MAPS GIS Goals and Objectives**

Lane's MAPS GIS project will:

- Strengthen STEM education by incorporating GIS applications that feature problem solving, critical thinking, collaborative learning, and, where applicable, concepts of participatory GIS;
- Introduce GIS to beginning students in a wide range of disciplines;
- Provide a pathway to advanced GIS studies by articulating beginning GIS with four-year university courses;
- Link beginning GIS education with four-year training and with industry and government needs; and
- Establish Lane as a leader in innovative GIS education in western Oregon.

### **GOAL #1: Increase GIS literacy among a broad undergraduate student population, especially those traditionally underrepresented in STEM disciplines.**

Objectives:

- 1.1 Increase the number of courses incorporating GIS problem-solving modules for majors and non-majors in science, social science, drafting, and computer science to sixteen or more courses, and thirty or more sections per quarter, serving about 700 students.
- 1.2 Significantly expand students' knowledge about GIS applications and interest in GIS-related careers within disciplines.
- 1.3 Increase the number of women, minority students, first-in-family college students, and rural students completing the GIS course sequence to at least 60 percent of students enrolled. (Among ATE programs evaluated in 2004, about one-third were women and one-third from minority groups [Coryn, Gullickson & Hanssen, 2004].)

### **GOAL #2: Provide a solid technical and conceptual foundation in GIS leading to expanded academic and career options.**

Objectives:

- 2.1 Align the GIS course sequence, internships, and capstone project with public and private sector job skills; and with national curriculum standards (NCGIA, 2000) for GIS education.
- 2.2 Articulate the GIS course sequence, internships, and capstone project with multiple academic pathways at Lane's transfer partner institutions.
- 2.3 Of students completing the course sequence with a grade of B or better, 70% will utilize their GIS skills in an academic program or related employment within two years of leaving Lane.

### **GOAL #3: Establish the technical capability and faculty resolve to make Lane the regional leader for lifelong GIS education and training.**

Objectives:

- 3.1 Provide the necessary technical infrastructure to support the GIS problem-solving and work-based instructional modules and for the three course GIS sequence.
- 3.2 Increase the number of faculty in STEM disciplines who are GIS literate and supportive of GIS education opportunities for students.
- 3.3 Create partnerships with regional GIS users and educators to expand GIS training in western Oregon.

### **Deliverables**

#### **Embedded GIS modules in science, social science, computer science, and drafting**

The project design team explored ideas for GIS modules with faculty from marine biology, environmental science, geology, forest ecology, human geography, physical geography, and computer science. This research provided insights into the feasibility of designing embedded modules. We anticipate using these “seed ideas” as a starting point for developing modules during the first year of the project and plan to work with the faculty who have already stepped forward.

We concluded that embedded modules should:

- provide relevant questions with research or policy implications, analogous to public and private sector decision making using GIS
- incorporate three and usually more data layers
- invite students to explore multiple spatial data layers to answer a focused question or to develop their own researchable questions
- involve cooperative learning and teamwork
- require students to understand how GIS data are acquired, manipulated and compiled (without having students actually do these steps)
- incorporate basic GIS tools like query, pan, and data layers to familiarize students with capabilities of GIS software
- run smoothly on existing classroom or lab computers

Modules will be developed by faculty in a variety of disciplines, working closely with our GIS curriculum specialist. This team approach will allow the GIS specialist to mentor faculty about GIS software and capabilities. Faculty who developed modules will in turn help other faculty. Expanding the breadth of MAPS modules and long-term sustainability depends on faculty-with-faculty collaboration. The faculty member will take primary responsibility for the curricular aspects. The GIS curriculum specialist will develop data and map layers and prepare files for the server. Faculty who want to design a module will receive a development “grant” of 100 hours of curriculum development funding to work with the GIS curriculum specialist. The 100 hours will include attending a two-day summer workshop with the GIS curriculum specialist and MAPS GIS team, developing the module, teaching it, assessing outcomes, and making revisions as necessary. This opportunity for faculty to develop curriculum, teach it, assess it, and revise it will help the college, over time, develop internal capacity to make GIS competency and analysis part of the regular delivery of curriculum and content matter, as appropriate.

Initially, a limited number of modules will be produced each year to ensure the highest quality. Since most courses are offered in multiple sections, each module will impact a large number of students. Modules will be developed for science and social science courses for majors and non-majors, as well as two professional technical program areas: computer information technology and drafting. At full implementation, we anticipate sixteen courses will incorporate GIS modules with as many as thirty course sections per quarter. Approximately 700 students a term will utilize GIS modules and realize the potential of these powerful tools for analyzing spatial data and solving problems.

Students who complete GIS modules will:

- Know how to use maps and other geographic representations and technologies to acquire, process, and report information from a spatial perspective.
- Know how to analyze the spatial organization of people, places, and environments.
- Develop critical thinking skills.
- Develop an understanding of GIS technology uses and applications.
- Know how to apply GIS to interpret the present and plan for the future.
- Gain awareness of STEM careers that utilize GIS.
- Develop awareness of the GIS training they may want to pursue.

A sample of courses with embedded modules is listed below.

**Science**

BI 101E, Ocean Life Foundations  
 BI 102H, Forest Biology  
 BI 103B, General Biology, Field Biology  
 BI 103J, General Biology, Forest Ecology  
 ENVS 181 Terrestrial Environment  
 ENVS 182 Atmospheric Environment and Population  
 ENVS 183 Aquatic Environment  
 G 101 Earth’s Dynamic Interior  
 G 102 Earths’ Dynamic Surface  
 G 201 Earth materials and Plate Tectonics  
 G 202 Earth’s Surface Systems

***and possibly***

BI 102B, Jungle Biology

**Social Science**

GEOG 101 The Natural Environment  
 GEOG 103 Cultural Geography  
 GEOG 201 World Regional Geography  
 GEOG 206 Geography of Oregon  
***and possibly***  
 ECON 260 Introduction to Environmental and Natural  
 Resource Economics  
 SOC 205 Social stratification and Social Systems  
 SOC 225 Social Problems

**CIT**

Anything other than CIT 247

**Drafting/CAD**

A number of different courses

**Module development guide for faculty and dissemination to other colleges**

The GIS curriculum specialist and module developers will develop a guide for designing embedded modules. The guide will assist faculty during and after the project, contributing to the project’s sustainability. The guide will include the design template, design process, module lesson plans, data sources, and links to the data layers developed for the modules. The guide will be in both a text format and an online format, available to faculty at other institutions. This “how-to” guide will be a significant component of the MAPS GIS dissemination plan.

**GIS course sequence**

The proposed three-course sequence, housed in Geography and Computer Information Technology (CIT), will be aimed at the entry-level student to build progressive steps in basic understanding of GIS and applied skills. The sequence will be designed to articulate with four-year institutions and local workforce needs. A preliminary survey of curricula at other regional institutions indicates that they focus on professional technical degrees for a self-selected group, upper-level courses, graduate degree programs, or some combination of the three. Our design will emphasize entry-level classes for first- and second-year college students and provide sound basic building blocks for further GIS education. The embedded modules will provide a “recruitment tool” for attracting underrepresented students to the GIS course sequence. The courses will be advertised by the participating divisions (Social Science, Science, Computer Information Technology, and Drafting). We plan to work closely with four-year institutions for articulation and with the MAPS Advisory Team to develop workforce skills within the curricula. We also will use the findings of the GIS Technician Task Verification Survey and the standards-based curricula developed by the Scalable Skills Certification Program (NSF #0401990). Development steps for the courses are listed in the Activities and Timeline chart, Table 1.

The first of a three-course sequence, Introduction to Cartography and GIS, will introduce fundamentals and provide students with a thorough grounding in cartography and spatial analysis concepts using computer technologies. The second course, Information Analysis, will provide data analysis skills and knowledge to validate and manipulate data to promote accuracy. The third course, Introduction to GIS Applications, will build on initial knowledge and skills by presenting more complex analytical problems and reducing instructor guidance to encourage more independent work and peer collaboration. Students will be assigned to small teams to complete the course with a capstone project. These courses will be articulated with STEM degree pathways supported by Lane’s transfer partners. The content of all the courses will be shaped by our curriculum analysis. The descriptions below reflect our initial thinking.

### GEOG 227 – Introduction to Cartography and GIS

This course introduces students to concepts of cartography, including map uses and interpretations; a variety of map types; and, map projections and coordinate systems. Students will gain experience using GPS (i.e., Geographic Positioning System) and GIS as a tool. The course will teach basic concepts of GIS data types such as raster, vector, DEM; operations such as address matching and query commands; scanning methods; editing vector data; and, basic production/printing.

### CIS 247 – Information Analysis

This is an introduction to basic information analysis concepts. Graphical and descriptive summaries of numeric values, value relationships, and time series are explored. Students learn forecasting techniques of graphical trends in time series through GIS decision support tools. Its goal is to help students understand how information is collected, manipulated, analyzed, used and misused, as well as build skills students will use as workers proficient and expert in GIS, as project leaders, and as managers. This course follows GEOG 227.

### GEOG 257 - Introduction to GIS Applications

The content of the third course will provide students with hands-on activities to use GIS for analysis of complex data. Students will gain knowledge and skills for generating, accessing, and validating spatial data sources for GIS use; converting data between formats and systems; and developing a GIS capstone project, including printed, digital, and oral presentation. Students may combine this project with job-shadowing or internship opportunities with the MAPS public and private sector advisors. This course follows CIS 247.

### MAPS GIS technical infrastructure

The MAPS project will be technically supported by a GIS server (ArcGIS), a database server (SQL-Server), and a web-server (Apache) residing on the college’s network infrastructure. The data will be accessible by students and faculty in all smart classrooms and lab rooms through the use of web-based technology. (We define “smart classroom” as one with computer technology that enables the instructor to project and demonstrate computer operations to all students.) Faculty and the GIS coordinator will also have access to the GIS server from their offices for development purposes. High DPI color printers for final copy and black & white printers for draft copies will be provided in each of the areas with embedded modules (science, computer science, drafting, and social science). The more specialized equipment, such as the large format printer and GPS devices along with Adobe’s Photoshop and Freehand software, will support the three-course sequence in GIS.

### **Activities and Timetable**

The MAPS GIS project will be a three-year endeavor, providing time and resources for curriculum development, faculty training, implementation within core courses, formative and summative evaluation, and dissemination and sharing of project materials and the MAPS model. Details of activities by year are shown in Table 1 below.

Table 1. Activities and Timeline

Outcomes	Activities		
	Year 1	Year 2	Year 3
1.1 Increase the number of courses incorporating GIS problem-solving modules for majors and non-majors in science, computer science and social science from none to 16 or more courses, and 30 or more sections per quarter, serving about 700 students.	<ol style="list-style-type: none"> <li>1. Develop modules for four courses, building on preliminary ideas.</li> <li>2. Develop initial module design template.</li> <li>3. Design, implement first summer GIS workshop.</li> <li>4. Assess outcomes and use results to improve workshop.</li> </ol>	<ol style="list-style-type: none"> <li>1. Develop six new modules, adding six courses to those using modules.</li> <li>2. Revise design template based on experiences.</li> <li>3. Run 2<sup>nd</sup> summer GIS workshop.</li> <li>4. Assess outcomes and use results to improve workshop.</li> <li>5. Develop and pilot first draft of Module Development Guide.</li> </ol>	<ol style="list-style-type: none"> <li>1. Develop six new modules, adding six more courses to those using modules.</li> <li>2. Revise Module Development Guide and prepare it for dissemination in print and on Web site.</li> <li>3. Develop ongoing mechanisms within each participating division for continued module use.</li> <li>4. Publish summative project results.</li> </ol>
1.2 Significantly expand students' knowledge about GIS applications and interest in GIS-related careers within disciplines.	<ol style="list-style-type: none"> <li>1. Design and pilot pre-/post-tests and survey instruments.</li> <li>2. Gather anecdotal data.</li> <li>3. Use results in iterative process to improve curriculum.</li> </ol>	<ol style="list-style-type: none"> <li>1. Calibrate instruments.</li> <li>2. Continue assessing students' knowledge and attitudes.</li> <li>3. Use results to improve modules.</li> </ol>	<ol style="list-style-type: none"> <li>1. Continue assessing students' knowledge and attitudes.</li> <li>2. Use results to improve modules.</li> <li>3. Publish summative project results.</li> </ol>
1.3 Increase the number of women, minority students, first-in-family college students, and rural students completing the GIS course sequence to at least 60% of students enrolled.	<ol style="list-style-type: none"> <li>1. Establish baseline of number of underrepresented students in courses using modules and related STEM courses.</li> <li>2. Advertise for first term GIS course.</li> </ol>	<ol style="list-style-type: none"> <li>1. Develop recruiting brochure and ads for GIS course sequence.</li> <li>2. Work with faculty in embedded module courses as "feeders" to the GIS sequence.</li> </ol>	<ol style="list-style-type: none"> <li>1. Survey demographics of GIS course sequence students.</li> <li>2. Assess recruitment efforts and results.</li> <li>3. Use results for continued improvement.</li> <li>4. Publish summative project results.</li> </ol>

<p>2.1 Align the GIS course sequence, internships, and capstone project with public and private sector job skills; and with national curriculum standards (<i>NCGIA</i>) for GIS education.</p>	<ol style="list-style-type: none"> <li>1. Complete workplace skill set analysis with advisory team members.</li> <li>2. Review of NCGIA Guidelines and existing ESRI education materials and models.</li> <li>3. Outline workplace-related learning outcomes for the MAPS GIS courses.</li> </ol> <p>See also Objective 2.2.</p>	<ol style="list-style-type: none"> <li>1. Develop capstone projects and internship opportunities for the third GIS course.</li> </ol> <p>See also Objective 2.2.</p>	<p>See also Objective 2.2.</p>
<p>2.2 Articulate the GIS course sequence, internships, and capstone project with multiple academic pathways at Lane’s transfer partner institutions.</p>	<ol style="list-style-type: none"> <li>1. Analyze course contents and entry-level knowledge and skills for partner university GIS courses.</li> <li>2. Develop sequential learning outcomes for MAPS GIS courses.</li> <li>3. Design GEOG 227 and CIS 247.</li> <li>4. Develop and obtain curriculum approval for the first two courses of the sequence .</li> </ol>	<ol style="list-style-type: none"> <li>1. Teach the first two courses of the sequence.</li> <li>2. Assess learning outcomes.</li> <li>3. Revise courses as needed.</li> <li>4. Design GEOG 257.</li> <li>5. Develop and obtain curriculum approval for the third course of the sequence.</li> </ol>	<ol style="list-style-type: none"> <li>1. Teach the three-course GIS sequence.</li> <li>2. Assess students learning outcomes, and curricular integrity.</li> <li>3. MAPS Advisory Team and consultants review goals and outcomes.</li> <li>4. Design strategies for ongoing revision with MAPS Advisory Team and consultants.</li> <li>5. Publish summative results.</li> </ol>
<p>2.3 Of students completing the GIS course sequence with a grade of B or better, 70% will utilize their GIS skills in an academic program or related employment within two years of leaving Lane.</p>	<ol style="list-style-type: none"> <li>1. Recruit students from courses using GIS modules to enroll in first two courses in the GIS sequence.</li> </ol>	<ol style="list-style-type: none"> <li>1. Recruit students from courses using GIS modules to enroll in the full GIS course sequence next year.</li> <li>2. Target recruiting and advertising to underrepresented students.</li> <li>3. Provide a “trailer” section of the third term for Fall, so first group of students can complete the sequence.</li> </ol>	<ol style="list-style-type: none"> <li>1. Design and implement career pathway survey and follow-up survey of GIS course students.</li> <li>2. Mainstream survey and follow-up for ongoing assessment.</li> <li>3. Publish summative results.</li> </ol>

<p>3.1 Provide the necessary technical infrastructure to support the GIS problem-solving and work-based instructional modules and for the three-course GIS sequence.</p>	<ol style="list-style-type: none"> <li>1. Install computer hardware and software to support ArcGIS and the SQL-Server.</li> <li>2. Upgrade existing laboratories used by STEM disciplines with specialized printing equipment for GIS.</li> <li>3. Upgrade the geography laboratory with specialized equipment and software for use by the GIS courses.</li> <li>4. Load data sets for various faculty modules.</li> </ol>	<ol style="list-style-type: none"> <li>1. Procure and install equipment in laboratory classrooms used by faculty with embedded modules.</li> <li>2. Load data sets for various faculty modules.</li> <li>3. Ensure web-based access to the ArcGIS server for classroom demonstrations in smart classrooms.</li> </ol>	<ol style="list-style-type: none"> <li>1. Procure GPS equipment for use by the GEOG 257 Introduction to GIS Applications, capstone course.</li> <li>2. Load data sets for various faculty modules.</li> <li>3. Evaluate success and sustainability of technical infrastructure.</li> <li>4. Publish summative results.</li> </ol>
<p>3.2 Increase the number of faculty in STEM disciplines who are GIS literate and supportive of GIS education opportunities for students.</p>	<ol style="list-style-type: none"> <li>1. Support module development and training for “early adopters”: faculty already interested in adding GIS to their courses.</li> <li>2. Provide Fall and Spring inservice session about the MAPS GIS project.</li> </ol>	<ol style="list-style-type: none"> <li>1. Using peer-to-peer model, support module development and training for additional faculty in STEM disciplines.</li> <li>2. Provide Fall and Spring inservice session about the MAPS GIS project.</li> <li>3. Design strategies for ongoing collegial support for GIS.</li> </ol>	<ol style="list-style-type: none"> <li>1. Expand module development and training for additional faculty in STEM and related disciplines.</li> <li>2. Provide Fall and Spring inservice session about the MAPS GIS project.</li> <li>3. Implement strategies for ongoing collegial support.</li> <li>4. Evaluate success in meeting this objective.</li> <li>5. Publish summative results.</li> </ol>
<p>3.3 Create partnerships with regional GIS users and educators to expand GIS training in Western Oregon.</p>	<ol style="list-style-type: none"> <li>1. Build on articulation and workplace alignment activities to forge concrete partnerships, beginning with MAPS advisory team.</li> <li>2. Sustain regular meetings and updates with Advisory Team.</li> <li>3. Visit with GIS educators at regional universities.</li> </ol>	<ol style="list-style-type: none"> <li>1. Continue regular meetings and updates with Advisory Team.</li> <li>2. Develop goals and strategies for Lane’s long-term objectives for GIS education in the region.</li> </ol>	<ol style="list-style-type: none"> <li>1. Evaluate success in meeting this objective, including survey of Advisory Team members.</li> <li>2. Publish summative results.</li> </ol>

## **Management Plan**

Faculty leaders from science, social science, and computer science developed the MAPS GIS project to be multidisciplinary. However, nationally most GIS education resides within geography disciplines. In keeping with that conceptual tradition, the Social Science Division, home to Lane's geography courses, will host the project, including fiscal oversight. The project will be managed by a team, lead by Jane Benjamin, senior Geography faculty at Lane, as project manager. Other members of the management team are co-PIs Lynn Songer (Geography/GIS), Linda Loft from Computer Information Technology (CIT), and Sarah Ulerick (Earth and Environmental Science). Their specific expertise and roles are outlined below. The management team is strongly supported by the Vice President for Instruction and Student Services, Dr. Sonya Christian, and the Division Chairs from each core area. The Office of Instruction and Student Services has supported this project with over \$9,200 in curriculum development funding for preliminary module design and grant development.

Lane Community College has a strong culture of faculty-led innovations. The MAPS GIS management strategy is in keeping with this culture and promotes rapid growth and dissemination of project goals among other faculty within each division. Curriculum development for the course sequence will be jointly supported by Geography, CIT, and Lane's drafting program. Faculty members from each of the core disciplines will function as subject matter experts for respective discipline-specific modules and will incorporate the modules into courses they are already teaching.

The management team will meet twice-monthly throughout the project. Meetings will address progress and obstacles to completing activities within the timeline; fiscal oversight; personnel; industry advisory team relationships and feedback; evaluation and reporting; and dissemination. All are seen as key elements of the project's success, and ongoing attention to these aspects will ensure that none are overlooked as the project evolves over time. Two outside consultants will advise on technical and conceptual issues, as needed, throughout the grant.

Fiscal oversight for the project is supported by Lane's Grants Accounting Office. Lane has approximately \$11 million in grant and contract funding, which is managed by this office for a number of different programs ranging from incentive funding to augment services under professional technical programs to providing first-year, first-in-family students with tailored support services to ensure their success. The Grants Accounting Office also reviews all grant applications to ensure that Lane's proposals meet all agency contractual requirements and are adequately and appropriately funded to ensure success.

## **Roles and Responsibilities of the PI, co-PIs**

Jane Benjamin, PI and Geography faculty, will direct the project. She will ensure adherence to NSF policy, achievement of goals and overall success of the project. Her role will be to diffuse information to the Co-PIs in twice-monthly meetings, set meeting agendas and project time lines. She will work closely with Lane's Funded Projects Office and Institutional Research and Planning department to manage and assess the project. In the larger context, Benjamin will write and present papers at conferences and communicate the value of this project with other institutions interested in undergraduate GIS education. The interdisciplinary aspect of Geography is important to the vision and sustainability of MAPS. Benjamin is committed to bring geographic knowledge and tools to as wide a range of students as possible, including women, minorities, and nontraditional students. Her experience and training in diversity leadership will strengthen the project team.

Lynn Songer, has ten years in geography education and expertise in developing GIS modules and teaching GIS. She serves as our GIS curriculum specialist. Songer will design and test GIS modules for geography courses and work with faculty in the other disciplines to design embedded modules for their

courses. Working with other team members, she will help develop and teach the GIS courses sequence. She will work with Loft in implementing the technical infrastructure for the project.

Linda Loft will coordinate Computer Information Technology's involvement in the MAPS project. These activities will include procurement and installation of equipment necessary to support the GIS three-course sequence as well as guiding CIT faculty in module development. Loft, Songer, and Benjamin will be the primary designers for the GIS courses and capstone projects. Loft is currently a member with over twenty-years standing on the faculty committee that oversees and approves college-wide curriculum and program development. As previous department chair of CIT for over fifteen years, she has considerable background in budget management for both program development and the equipment necessary for professional/technical curricula. Her expertise will also help Lane transition the program when the grant period has ended.

Sarah Ulerick (Earth and Environmental Science) has been a faculty member at Lane for nine years and was the college Grant Coordinator for seven years prior to that. Ulerick chairs the college Assessment Team and leads program assessment efforts in Science. She will lend her assessment expertise to design and implement formative and summative evaluations for learning outcomes, module quality and project goals, working closely with the project's outside evaluator in this effort. In addition, her background in grants will assist the management team. As lead faculty for Earth and Environmental Sciences, she oversees nearly forty sections of laboratory science classes for majors and non-majors each year. Part-time faculty in Earth and Environmental Science were involved in developing initial module discussions and will be among early implementers.

### Key Personnel

Two faculty members will play key roles in carrying out MAPS GIS activities. Albert Pooth, Biology faculty member, will be the lead faculty for module development in Science. Pooth already has some experience with GIS and is ready to develop modules for Marine Biology. As a fulltime member of the Science faculty, he will be available to assist other faculty as development progresses.

Fred Beisse, Computer Information Technology faculty, will work with the MAPS team on the GIS course sequence and will initially teach the middle course, CIT 247. Beisse has many years experience teaching and developing work-based CIT curricula. His expertise strengthens our curriculum development in this key area.

### Partners and Advisors

The MAPS GIS Advisory Team members will help define knowledge and applied skill objectives for GIS curriculum; advise on course articulation to four-year programs; provide GIS-related internships and job-shadowing opportunities for students; and assist in providing industry-relevant problem contexts for GIS modules. The Advisory team was formed during development of this proposal, and the group helped to shape the form of the MAPS GIS project. The team is composed of industry and government (employer) representatives and representatives from partner colleges and universities:

- Jay Rugger, Bureau of Land Management
- Eric Brandt, Program Manager/GIS Database, Lane Council of Governments (LCOG)
- Connie Scolla, Lane Council of Governments (LCOG)
- Dennis Vanwinkle, Weyerhaeuser Company
- Kevin Biersdorff, Eugene Water and Electric Board (EWEB)
- Mike Miller, Eugene Public Works
- Stan Lenhart, Crime Analyst, Eugene Police Department
- Mike Jones, Director of GIS Professional Technical Program, Clackamas Community College

- Marc Schlossberg, Assistant Professor Planning, Public Policy, and Management, University of Oregon
- Amy Lobben, Assistant Professor, Department of Geography, University of Oregon
- Dawn Wright, Professor, Department of Geosciences, Oregon State University
- Dr. Sriram Khé, Chair, Department of Geography, Western Oregon University

The project team will consult with leaders of business and industry to ensure that curriculum and learning activities contain the key elements of the workforce and workplace, and will work with academic members for articulation planning. Periodic briefings by the Management Team and module reviews will keep the Advisory Team informed of progress and products. The Advisory Team will meet with the Management Team twice each year for a formal review. Additional meetings will be held as needed to gather advice on aspects of the project. Members have committed to ongoing support, including reviewing quarterly updates of progress, attending team meetings, developing internship opportunities for GIS students, and providing input for work-relevant capstone projects.

### Consultants

The project will contract with two outside consultants to provide advise and assistance in developing the MAPS GIS project. One of the consultants will also assist with project evaluation. Art Benefiel, is the program director for GIS at Central Oregon Community College where he has developed both one-year and two-year certificate programs and is active in developing GIS education. Benefiel will meet consistently each term with the MAPS Team to offer support and suggestions pertaining to technical obstacles, project alignment and clarity. He will be available throughout the grant for consulting by telephone and email as needed.

Dr. Dawn Wright of Oregon State University will provide a four-year college perspective and assist Lane in developing articulation agreements with Oregon State University and other four-year universities in the State of Oregon. As a faculty member of Oregon State's Department of Geosciences, she will assist Lane's team by providing technical expertise on integrating GIS systems within existing curricula. Dr. Wright will also serve as the outside evaluator of the project.

### **Qualifications of Host Institute, Facilities and Resources**

Our capacity to achieve the objectives of the MAPS GIS project is evidenced by Lane's:

**Excellence:** Lane has been rated as one of the nation's top community colleges in multiple studies over the last twenty-five years and has received many awards and accolades for its innovative programs. The American Council on Education and the American Association of Community Colleges cited Lane for excellence in "A Learning College for the 21st Century" (1997). Lane received the David Pierce Organizational Leadership Award from the National Institute of Leadership and Institutional Effectiveness in 1998.

**Leadership:** Lane's reputation for excellence has earned it membership in the League for Innovation in the Community College. Since 1973, Lane has been one of only nineteen board member colleges in the 700-member League. The League defines itself as "the only major international organization specifically committed to improving community colleges through innovation, experimentation, and institutional transformation." Through the League, Lane exchanges innovative ideas and practices with some of the best community colleges in the United States.

**Commitment to learning:** Lane has long been recognized as an emerging model of the learning college. In 2000, Lane was selected as one of 12 Vanguard colleges. Vanguard colleges will assist other community colleges in the United States and Canada to become more learning centered by creating a network of community colleges strongly committed to the Learning College concept, whose efforts can

serve as a basis for model programs and best practices. Ultimately, these colleges will serve as incubators and catalysts for the Learning College concept for other educational institutions around the world.

**Exemplary record in obtaining and administering external funds:** Activities supported by federal funds include Lane's nationally recognized Cooperative Education program; our Dislocated Worker Program; and Transitions To Success, Lane's program for displaced homemakers and single parents. Other notable grants the college has received over the past few years include a five-year, \$1,110,000 Student Support Services TRIO grant from the U.S. Department of Education to provide services for at-risk students and a \$300,000 Oregon Economic and Community Development Department grant to provide training for incumbent health care workers. In 2003-2004, Lane received and managed nearly \$11 million in grant and contract funds, excluding federal financial aid.

Lane is fertile for the MAPS GIS project. The Division Chairs and faculty in Social Science, Science, CIT and CAD/Drafting are excited about implementing embedded GIS modules and providing further GIS education through the three-course sequence. The Vice President for Instruction and Student Services is committed to developing Lane's GIS curriculum and leadership role in GIS education in the region. Finally, this project aligns with Lane's aim to foster widespread faculty expertise about assessment and to provide assessment support for all projects.

### **Plan for Sustainability after NSF funding**

Plans for sustainability of MAPS at Lane guided the design of the project. Sustaining the embedded modules as vital components of a wide range of courses will require maintenance of computer technology and auxiliary technology; ongoing assessment of learning outcomes; ongoing faculty development and support; support for a GIS multidisciplinary interest group at Lane; and continued support from college leaders. Sustaining the GIS course sequence, internships, and capstone projects will require regular assessment of their outcomes; continued access to well-equipped computer labs; ongoing participation and commitment from the Advisory Team; and continued recruitment of students from general education courses utilizing the embedded modules. These are design elements that support sustaining the MAPS GIS activities:

- Peer-to-peer mentoring for module development will ensure that a cadre of enthusiastic faculty exists to sustain the embedded modules.
- GIS modules will be embedded in standard courses in core disciplines and maintained with the core curriculum of the courses.
- The Module Development Guide will be key to assisting faculty to continue adding modules to additional courses.
- The large number of course sections using embedded modules will provide a natural recruiting mechanism for the GIS courses.
- The GIS technical infrastructure will be supported by college-wide technology maintenance and support for instructional technology.
- Well-conceived articulation agreements with four-year colleges will ensure students make academic progress that builds on their GIS knowledge and skills.
- For the GIS courses, the anticipated enrollment and resulting tuition-based revenues will support continued development and updates.
- Strong Advisory Team collaboration throughout the project will continue to be supported by the participating divisions and by the Office of Instruction and Student Services.
- Strong support from faculty and administrators for GIS education at Lane will encourage growth and remove obstacles to sustaining the MAPS GIS model.

## **Plan for Future Expansion**

The project team, with strong commitment from Lane's President, Dr. Mary Spilde, and Vice President, Dr. Sonya Christian, view the MAPS GIS project as a necessary first step to generate the knowledge, experience, and interest among faculty and the technical infrastructure for developing a viable professional technical GIS program. Many community college GIS programs falter because they depend on one or two extremely dedicated faculty for sustainability. Programs can become insular and separated from the STEM disciplines that are natural partners and feeder programs. The MAPS program will develop a large cadre of faculty with a vested interest in expanding GIS education opportunities for students. In addition, the strong articulation agreements developed by MAPS will provide a basis for extending the articulation options of a more technical GIS program. Finally, MAPS will have maintained solid relationships with its Advisory Team for ongoing support of a professional technical degree program.

## **Evaluation Plan**

A comprehensive evaluation plan will ensure the achievement of project goals and facilitate sustainability of MAPS. Both formative and summative evaluations will be built into ongoing activities. Formative evaluation will include implementation evaluation, tracking the effectiveness of the project development activities, and progress evaluation, assessing how activities contribute to meeting stated goals. Summative evaluation will focus on the impact on students, with emphases on enrollment and success of underrepresented students. Summative evaluation is relevant to the sustainability and replicability of the program. Co-PI Sarah Ulerick will lead evaluation and assessment within the project team, working closely with our external evaluator, Dr. Dawn Wright. Early on, the project team with Dr. Wright's assistance will design a logic model (as described in *The 2002 User-Friendly Handbook for Project Evaluation* [NSF 02-057]) showing components of the project and the expected outcomes. The model will guide implementation of evaluation activities.

Formatively, the Management Team will develop a progress-monitoring system early in the first year of the project to set milestones and detailed timelines for each of the project objectives and activities. The Management Team will develop a system to keep track of how well the objectives and activities are being implemented, with planned correctional/re-directional activities built in for goals that are not progressing adequately. Qualitative data sources may include records of meetings, open-ended survey questions, and documentation of problems and solutions. The External Evaluator will review this system and make recommendations to ensure quality results.

Summatively, a set of indicators (again, early in the first year of the project) associated with each objective will be built, with data collection activities, instrumentation, data analysis, and data presentation plans detailed for each objective. In general, our approach to summative evaluation for each objective will be to assess comparative baseline data in the first year of the project, and then track gains in student knowledge, skills, and attitudes, along with enrollment numbers throughout the project. The project will implement a long-term follow-up of GIS sequence students; the results of this measure will not be known within the project period but will be reported in the ongoing assessment of the GIS sequence courses. The module developers and External Evaluator will develop one or more common exam questions and a common survey for the effects of the embedded modules. Equally important, ongoing use of these results will provide information that will enable the MAPS project to improve its methods during the three-year development period and beyond.

The PI will compile annual reports that include a summary of implementation evaluation, progress toward project goals and objectives, and recommendations to address issues that arose. The final evaluation report will document an account of the development of the MAPS GIS project; establish to what extent and in what ways the defined goals and objectives of the project have been met; establish

whether the project has been fully implemented as planned; and assess the effectiveness of the dissemination of the exemplary model.

### **Dissemination Plan**

The PI and Co-PIs will collaborate on presentations, papers, and design of outreach materials. Progress and results will be shared through four avenues:

Module Development Guide: The guide (print and online) for developing embedded GIS modules will disseminate both the methods used to develop the modules and the modules themselves. The guide will serve faculty at Lane and other colleges who want to develop similar GIS activities for their classes. This resource will allow the MAPS model to be implemented at two- and four-year colleges across country.

MAPS web site: The PI will develop and maintain a Web site with the program design and outcomes of the MAPS project. This Web site will have a counter to record the number of “hits” made to the Web site. The web site will post the MAPS model, activities, milestones, events, and outcomes. GIS modules developed at Lane will be available to interested faculty via the Web site. The PI will update the Web site as new lessons for successful implementation are learned.

Conferences and presentations: MAPS GIS program design and outcomes will be shared with STEM faculty and instructional administrators through presentations at conferences. The PI, co-PIs, and involved faculty will present at conferences of the Association of Pacific Geographers, Association of American Geographers, and other groups related to the MAPS project, including the League for Innovation. The MAPS team members also will present MAPS project design and outcomes to faculty and instructional administrators at community colleges in Oregon.

Published papers: The PI, co-PIs, and participating faculty will write one or more papers describing the MAPS GIS project and the assessed outcomes of the project. Because modules will be embedded in such a range of disciplines, this avenue has the potential to impact GIS education in many STEM disciplines. Papers will be submitted to appropriate STEM education journals and to the ERIC database.

Ultimately, the success of the MAPS GIS project – and its significance for transforming our promising project into a regional and national resource – lies in our commitment to meaningful evaluation and dissemination activities. Participation by the college staff in the planning and evaluation process constitutes a significant investment of internal resources and demonstrates the college’s commitment to creating and maintaining the MAPS approach to teaching GIS literacy and basic skills.

### **Results from Prior NSF Support**

The PIs and co-PIs have not received previous NSF funding and have no pending support.