

**A Scalable Skills Certification Program in Geographic Information Systems (GIS)  
Grant from the National Science Foundation Advanced Technological Education Program  
Year 3 Mid-Term Evaluation  
October 1, 2006 – March 31, 2007**

**Introduction**

San Diego Mesa College, in partnership with San Diego State University and San Diego City Schools, was awarded a three-year Advanced Technological Education (ATE) grant from the National Science Foundation. The three-year grant started October 31, 2004. A one-year, no-cost extension of the grant will take the grant term through September 30, 2009. This evaluation report details the project's progress in meeting its goals and objectives during the first half of the third year of the project, from October 1, 2006 through March 31, 2007. Because the National Science Foundation agreed to a no-cost extension of the term of the grant a fourth year, this evaluation treats the 2006-2007 project year as the second year of the project.

On March 6, 2007, Dr. Phyllis Sensenig met with Eileen Goff, Principal Investigator, and Dr. Otto Lee, Co-Principal Investigator and Dean of the School of Business, Computer Studies and Technologies at Mesa College to review the project goals and objectives, activities, and evaluation plan and timeline. On March 16, 2007, Dr. Sensenig met with Ms. Goff, Dr. Ming Tsou and Dr. Carl Eckberg, Co-PIs at San Diego State University, two of the project graduate students, and four Mesa College GIS faculty members (John Johnson, Kim Mathis, Casey Cook and John Ryan) to discuss the project and the development of the skills certifications. Dr. Sensenig attended the National Visiting Committee session on April 16, 2007, and reviewed the Committee's findings and recommendations from the first three years of the project.

**Program Implementation**

Ms. Eileen Goff became the Co-Principal Investigator from Mesa College in February 2006. The second Co-PI from Mesa College, Dr. Otto Lee, is Dean of the School of Business, Computer Studies and Technologies and provides administrative support and leadership to the project. John Johnson has continued working with the project as a participating faculty member. Several other faculty members in GIS and from other disciplines also have joined the project, expanding the access to content-area expertise and to experience in creating new curriculum and academic programs and shepherding them through the district curriculum approval process.

The San Diego Regional GIS Council continues to serve as the project's advisory committee. Ms. Goff, Principal Investigator (PI), has attended meetings of the Council and has provided them with quarterly status reports on the project's progress.

The third National Visiting Committee meeting was conducted on April 16, 2007. In addition to the Visiting Committee members, the meeting was attended by the Mesa College President, the SDCCD Vice Chancellor/Chief Instructional Officer, participating administrators, faculty and students, and several participating high school teachers. The Visiting Committee members received a comprehensive report of the project progress, including the website. The National

Visiting Committee's report included specific recommendations concerning the development of a full-time Mesa College faculty position to lead the GIS program; completion of the DACUM process linking the modules to the knowledge and skills assessment; document the work of developing the skills certificates, including what other organizations and institutions have done; publish and disseminate results of the mapping of the UCGIS Body of Knowledge to the skills and competencies identified in the DACUM; work on qualifying GISC 104 as a General Education course at Mesa College; and collaborate with other regional colleges to promote articulation with the university systems.

### **Progress toward Achieving Project Objectives and Deliverables**

***Objective 1: Develop skills certificates at identified levels of training, to certify specific work-based competencies.***

#### Year 2 activities:

- The GIS Educational Consortium will develop project-based certification procedures, and will utilize them to award independent employment skills certifications to students who successfully complete the skills certification courses and pass the project-based certification tests.

Ms. Goff has worked closely with other participating GIS faculty to map the tasks identified in the DACUM to the GIS curriculum. This mapping was completed for six courses:

- GISG 104: Geographic Information Science and Spatial Reasoning. This is an introductory survey course designed to match the GIS 104 class developed at SDSU. This course also meets the Mesa College mathematics graduation requirement and provides general education credit, and so will be likely to attract more students to the program. The faculty team created a completely new course outline for GISG 104, and developed the Course Outlines and materials required to submit the GISG 104 course to the Districtwide curriculum committee in fall 2006. However, they then discovered that SDSU has a math prerequisite for this class, so they pulled the outline to add that to their curriculum. The course was in the final stages of approval through the Curriculum Committee in March 2007.
- GISG 110: Introduction to Mapping and Geographic Information Systems. This is the foundation course for the GIS program. The faculty team determined that only minor changes were needed to the existing approved GISG 110 course, and submitted those changes for approval to the Districtwide curriculum committee in fall 2006. The changes to this course have been approved by the Curriculum Committee.
- GISG 111: GIS and Cartography (was Geographic Information Systems Intermediate Applications). The course approval materials have been developed and are in the CurricuNet system now.

- GISG 112: Geoprocessing and Spatial Analysis. The course outlines and materials have been developed and reviewed by the adjunct faculty team, and is ready to enter the CurricuNet system.
- GISG 113: Advanced Geographic Information Systems Applications. The team planned to begin preparing the revised course outlines and curriculum application materials for GISG 113 in late March 2007.
- GISG 114: Geodatabases. The team has developed the outlines for this course, and will enter them into the CurricuNet system once the other courses are submitted. This new course will be taught for the first time in the spring 2008 semester.

The original proposal called for the GIS Educational Consortium (the Co-PIs and project staff) to develop project-based certification procedures to award independent employment skills certifications to students who successfully complete the skills certification courses and pass the project-based certification tests. The newly constituted curriculum team has recognized that it will be necessary to get the revised course curriculum approved through the district curriculum development process before separate skills certifications can be identified. The team has tentatively identified six skills certifications that may be awarded through successful completion of GISG courses:

- Georeferencing – Scanning/Digitizing (GISG 111)
- Cartography (GISG 111)
- Spatial Analyst (GISG 112)
- Spatial Geoprocessing (GISG 112)
- Advanced Spatial Geoprocessing (GISG 113)
- Geodatabases (GISG 114)

The faculty team concluded that GISG 104 and 110 are both designed to lay the groundwork students need to succeed in more advanced coursework and are too basic to provide the level of skills that an employer would find meaningful in a certification. Therefore, the team does not anticipate making skills certifications available until GISG 111. They also decided to drop the second certificate they had planned for GISG 111 (in GPS data collection) because they do not spend enough time on this in the class to feel that it warrants providing a certificate.

The project team plans to be developing the certifications policies and procedures during the second half of this project year.

#### Year 2 Deliverables:

1. *Certification policies and procedures.* This is in progress, and should be completed as the new and modified course outlines are approved by the District curriculum committee. Draft policies and procedures are expected to be developed during the second half of Year 3 of the project.

***Objective 2: Develop a standards-based curriculum, aligned across the three educational levels, designed to meet identified industry needs. The project-based curriculum will be linked to job descriptions, will integrate Geography and Computer Science, and will include a work-based component focused on career ladders in GIS.***

Year 2 Activities:

- Develop the curriculum needed for the skills certifications. The curriculum will be aligned across the three educational levels (high school, community college and university).
- Develop project-based activities for the skills certification courses. The GIS curriculum development faculty team decided to make each GISG course include both lecture and laboratory to ensure that project-based activities are included in each course. They are developing specific project-based laboratory activities for each class to provide students with more hands-on experience in GIS applications. These laboratories will be part of the courses that will be associated with skills certifications. The project-based activities have been developed for GISG 104, 110, and 112; they are in progress for the other courses.
- Offer the skills certification courses to students at the high school, community college and university levels.
- Arrange internship opportunities for students in the skills certification programs. John Johnson and other GIS faculty supervised 10 students in GIS internships during the summer 2006 college session and will supervise additional internships during summer 2007.

Year 2 Deliverables:

1. *Curriculum outlines and approvals.* The approval process has been completed for GISG 104 and 110 and is in progress for GISG 111. The faculty team is reviewing the course outlines and materials for GISG 112 in spring 2007.
2. *Outlines of project-based activities for the skills certification courses.* This is now underway as part of the curriculum development and approval process, and is completed for GISG 104, 110 and 112. Project-based activity development is expected to be completed by the end of 2007.
3. *Program enrollment and completion.* Mesa College currently enrolls 30-50 students in its GIS program. Until the curriculum development and certificate processes are complete, student enrollments can not be counted toward this deliverable.
4. *Internship completion.* Ten student internships were completed in summer 2006.

***Objective 3: Create articulation agreements across the three educational levels to ensure that students are able to progress efficiently through the educational programs.***

Year 2 activities:

- Draft articulation agreements
- Obtain approval at each level
- Sign agreements

Mesa College and SDSU have developed fully articulated, matching lower-division GIS General Education courses. In the first project year, San Diego State University developed a new lower-division General Education GIS course, GEOG 104 (Geographic Information Science and Spatial Reasoning). Co-PI Ming Tsou utilized the DACUM results in developing the course, which was approved by the University in late September 2005. The course was taught for the first time in the Fall 2006 semester. Dr. Tsou noted that he has already been contacted by several other community colleges to articulate the course with community college courses in several disciplines, including geography, computer science and anthropology. In addition, Carl Eckberg, Professor of Computer Science at SDSU and a senior project participant, is adding GIS components to his Computer Science 105 course. This course will become a connection at the lower division level (and through the joint GIS certificate program) between the SDSU Geography and Computer Science departments.

Mesa College faculty designed the GISG 104 course (which has received district curriculum approval) to articulate with the SDSU GEOG 104 course, including the mathematics prerequisite. The Mesa College Articulation Officer and the Vice President of Instruction are now developing formal articulation agreements with SDSU. The other courses in the Mesa College GIS sequence will be associate degree courses only. The Mesa College and SDSU faculty must further discuss whether the course credit for these courses will be able to transfer to SDSU for general education requirements.

Year 2 Deliverables:

*Formal articulation agreements developed and signed.* This is currently under development by the Mesa College Articulation Officer.

***Objective 4: Prepare high school teachers and post-secondary faculty to provide the GIS skills training.***

Year 2 activities:

- Teacher and faculty training workshops and programs will be developed and offered.

In the initial year of the project, project staff offered teacher training on GIS that was coordinated with a large-scale teacher training on implementing project-based learning. This is a workshop that the San Diego Unified School District offered in summer 2005 for high school teachers. Over 100 teachers attended three workshops on integrating GIS into the high school curriculum during the summer of 2005. The teacher response was enthusiastic, and many indicated an interest in integrating GIS into their school programs. Several have contacted the Co-PIs individually requesting help in implementing GIS activities in their classes. However, project staff members were not able to follow-up on this training on an individual basis with interested teachers. No training materials or curriculum that the teachers could use had yet been developed by the project.

Dr. Tsou and his graduate students worked with three schools (High Tech High, Helix Charter High School, and Hoover High School, which became involved after the summer training events) to develop GIS modules for their courses. This work was very intensive with each school and created online GIS modules specific to the projects participating teachers were implementing. However, the materials developed were too specific to individual projects to enable other teachers to utilize them. Helix High has created a two-year GIS program based on the project modules developed by SDSU. It is not clear whether these modules are equivalent to the Mesa College GIS courses, or whether they are designed to provide preparation for a baccalaureate program (rather than a technical education program at a community college).

During the 2005-2006 project year, project staff scheduled a workshop in June 2006 to train high school teachers on the GIS module materials developed for the grant (see Objective 5 below). However, the workshop was cancelled due to lack of enrollment. Ms. Goff then enlisted the assistance of Ms. Lynne Ornelas, SDCCD Associate Dean of Economic and Workforce Development to help recruit teachers to participate. Ms. Ornelas helped facilitate a linkage with Mr. Ralph West of the San Diego Unified School District's School-to-Career Office, who helped Ms. Goff recruit high school teachers to participate in a workshop scheduled for November 3, 2006. Ms. Goff collected and analyzed teacher feedback from this workshop. Most of the 12 teachers who attended reported that they are or will be using the Career Awareness Modules in their classes.

During the second year of implementation, Ms. Rebecca Arnold, an economics professor at Mesa College, became intrigued by the applications of GIS to economics and became an active participant in the project. Ms. Arnold, who once worked with the San Diego Association of Governments and has a background in the use of GIS applications in government planning, completed a course from ESRI in using ARCGIS, and then received extensive one-on-one training and support from Ms. Goff as she implemented GIS into her curriculum. Ms. Arnold incorporated GIS in teaching microeconomics (starting in April 2006); economics and GIS students began working together to create mapping projects in fall 2006. Ms. Arnold received a grant from the National Endowment for the Humanities to compare student learning in a traditional economics course and in one enriched with GIS; her results found that although test scores and understanding of economic relationships did not differ significantly, students enjoyed and preferred working with GIS maps.

In addition, two CISC Principles of Information Systems courses began introducing geospatial technologies beginning in fall 2006, and began a class project incorporating GIS in spring 2007. An Art History course will incorporate GIS maps to locate “historically important” ancient cultures starting in spring 2007.

#### Year 2 Deliverables:

1. *Teacher and faculty training workshops conducted and attended to capacity.* In the first year of implementation, four high school teacher training workshops (one at High Tech High, three through San Diego City Schools) were conducted and fully attended. Dr. Tsou and Mr. Anthony Howser followed up this training with several visits to High Tech High and Helix Charter High School to coordinate the development of the web-based learning modules and introduce web-based GIS tools to teachers. These were one-on-one training sessions rather than workshops. No community college faculty training in GIS was conducted. Although no training workshops were conducted during the second year of implementation, project staff members did develop the high school GIS exploration modules (see Objective 5), develop training workshop agendas, and were able to develop a mechanism to recruit teachers. The first workshop was held November 3, 2006 and attended by 12 teachers.

Ms. Arnold and Ms. Goff create a faculty development workshop on the interdisciplinary nature of GIS and the opportunities to incorporate GIS into other programs throughout the College. This workshop was offered during the pre-semester professional development in January 2007, and attended by seven faculty members.

***Objective 5: Develop a Web-based GIS career awareness program to encourage students to pursue careers in the field and enhance enrollment in technician training and educational programs.***

#### Year 2 activities:

- GIS career awareness program will be pilot-tested, revised as needed, and disseminated to schools and career centers.
- Students who complete program course successfully will be awarded initial skills certificate.

At the start of the project, the Co-PIs considered trying to develop a full GIS course for high school students. However, after initial meetings with teachers and school staff (at High Tech High and Helix Charter High School – both charter schools) they concluded that this was not feasible for the first year of the project, and instead chose to focus on developing GIS modules that can be used within current courses to introduce students to GIS technology while reinforcing concepts they are learning in their existing courses.

During the first year of implementation, Dr. Tsou and Dr. Eckberg worked with their four graduate students to develop web-based GIS programs for high school students. They uploaded

onto their website (<http://geoinfo.sdsu.edu/hightech>) information about the project, three web-based learning modules (developed in collaboration with High Tech High, Helix Charter High School and Hoover High), and five Internet maps. The team created two versions of the learning modules; a desktop version for students without broadband Internet access, and a web version for students with high speed Internet access. However, the website as developed focused primarily on the web-based course modules created with the high schools rather than on the career awareness program proposed to encourage students to pursue careers in the field and enhance enrollment in technician training and educational programs. Although these web-based courses created with the high schools do introduce basic GIS concepts and resources, their primary focus is not on the career awareness information originally proposed. The website did have some links to general information about GIS and career information in occupations that use GIS. However, this content was not easy to find, being deep in the web page structure. The National Visiting Committee, at their March 2006 visit, noted that this activity did not seem to be connected to the rest of the project.

The Year 1 evaluation report noted that the main page of the website should provide easy access to career information that includes types of jobs, the education and training required for each, types of industries and businesses that employ these positions, career pathways, salary information, and links to other sites for additional information.

During the second year of implementation, project staff from SDSU revised the website to include a broad overview of GIS, information about careers in the field, links to other sources of information, and four career learning modules:

- **Module 1: The Digital Globe.** This two-hour module introduces the concept of the digital earth, demonstrating to students how useful it is to spatially represent data and imagery on a virtual globe. Students learn to use engaging software such as Google Earth and Geofusion's GeoPlayer.
- **Module 2: GIS Applications in Various Fields.** This 1.5-hour module introduces various GIS applications and illustrates their usefulness in different specialty areas (such as criminal justice, environmental science, real estate, and election campaign).
- **Module 3: The Cutting Edge and Future of GIS.** This 1.5-hour module introduces various advanced and applied uses of GIS applications that will be prevalent in society, government and industry in the near future. Sample topics include Multimedia GIS Visualization of the 2003 San Diego wildfires and the use of mobile GIS for habitat monitoring.
- **Module 4: Putting It All Together – Our Future with GIS.** In this one-hour module, students will synthesize what they have learned in the first three modules, explore how GIS can be a valuable tool for businesses, organizations and society, and reflect on why GIS skills would be useful in a variety of careers.

Each career learning module includes a worksheet for student and teacher use, an answer sheet, and quick links to other resources. The SDSU team identified the following student learning outcomes for the four GIS modules:



1. Understand the value of GIS skills and the potential of GIS careers (module 4)
2. Explain the fundamental GIS concepts, coordinate systems, and the idea of Digital Globe (module 1)
3. Describe at least two GIS applications in various industries and careers (module 2)
4. Identify at least two new directions for future GIS applications (such as mobile GIS, multimedia, visualization, and participatory GIS (module 3)

Educational Technology Resource Teachers from the San Diego Unified School District reviewed the modules in March 2005 and reported that at least one program used was not compatible with the Macintosh platform. They also indicated that the modules did not focus directly on the state content standards, which means that teachers would be less likely to use them. In response to this feedback, SDSU revised the modules to ensure that they are compatible with the Mac Operating system. The second version upgrades to Google Earth 4.0, separated the answer sheets from the exercise instructions, and added a component to get students' feedback about the learning modules.

SDSU reported that there has been significant increase in the number of total visitors to the website. While the total number of hits to the website increased by 6.7% (when comparing the periods of March 2005/March 2006 with March 2006/March 2007), the number of visitors increased by 155% (from 17,067 in 05/06 to 43,565 in 06/07), and the number of unique IPs visiting the website increased by 287% (from 3,559 to 13,779).

#### Year 2 Deliverables:

1. *Student completion of web-based courses.* During the first year of implementation, the Web-based course at Helix High was developed for use by approximately 120 students. Approximately 30 students in the biology class at High Tech High were to use the module developed with that school.

The learning modules developed during the second year of the project implementation may be used by a wide range of schools; workshops to prepare teachers to implement them with their students were designed and will be offered starting in November 2006. One teacher at Hoover High (who had participated in the customized modules) reported that she started using them in her Computer Technology class (with 20-30 students) in Fall 2006. The project will be able to track student completion of the modules because teachers must register their students by name to obtain the passwords students need to complete the final sections of the learning modules. This will provide data on the number of students nearing completion of the career learning modules program.

2. *Courses accessed by high schools and career centers.* SDSU reported that 203 students have been granted access to the GIS modules.

3. *Initial skills certificates awarded.* Eight students at Helix High School have completed the four modules and received certificates from SDSU.

***Objective 6: Share the model GIS skills certification and technician training program with other educational institutions and communities across the U.S.***

Year 2 activities:

- Information about the GIS skills certification program will be disseminated to other educational institutions and industry through website and presentations at selected conferences.

The project Co-PIs and graduate students have undertaken a variety of activities to disseminate information about project activities. The project website includes information about project activities and progress. The website had logged 332,482 hits between March 2005 and March 2006, with 43,565 total visitors (and 13,377 unique visitors).

The Co-PIs presented information about the project at several conferences during the first year of the project:

- Dr. Tsou organized two GIS educational sessions at the annual meeting of the Association of American Geographers, April 7, 2005, in Denver Colorado.
- Dr. Tsou presented a paper “Adopting Web-Based GIS for the Development of a Scalable GIS Education Program” at the annual meeting of the Association of American Geographers, April 7, 2005, in Denver Colorado.
- Dr. Tsou and Mr. Johnson presented several papers at the 2005 ESRI Education User Conference in San Diego in July 2005:
  - Tsou: “Web and Mobile GIS for High School GIS Career Awareness”
  - Johnson: “DACUM Curriculum Analysis for GIS Technicians”
  - Johnson: “The Future of GIS Education at the Community College.”

During the second year of implementation, Dr. Tsou and Mr. Johnson presented papers at the 2006 ESRI Education User Conference in August 2006:

- Johnson: “Systematic Curriculum and Instructional Development (SCID) using DACUM.”
- Ming-Hsiang Tsou and Jing-Yi Chen: A Web-Based Scalable GIS Education Program for High Schools.  
<http://gis.esri.com/library/userconf/educ06/abstracts/a1934.html>

Dr. Tsou also presented a conference paper session on March 9, 2006 at the 2006 Association of American Geographers Conference, entitled Web-based GIS for Bridging the Gap of GIS Education between Universities and High Schools.

([http://communicate.aag.org/eseries/aag\\_org/program/AbstractDetail.cfm?AbstractID=5142](http://communicate.aag.org/eseries/aag_org/program/AbstractDetail.cfm?AbstractID=5142))

Dr. Tsou also published two articles related to the project:

- Tsou, M.H., Guo, L., and Howser, T. (2005). A Web-based Java Framework for Cross-Platform Mobile GIS and Remote Sensing Applications. *GIScience & Remote Sensing*. 42(4). Pp. 333-357.
- Ming-Hsiang Tsou, (In Press now). The Integration of Internet GIS and Wireless Mobile GIS. In *Manual of GIS*, edited by Marguerite Madden, published by the American Society for Photogrammetry and Remote Sensing (ASPRS).

Dr. Tsou submitted another article for publication: Ming-Hsiang Tsou and Jing-Yi Chen (In preparation) "Implementation and Evaluation of Web-based Geographic Information System (GIS) in High School Education" to the *Journal of Geography* for their special issue: Using Geospatial Data in Geographic Education (the submission deadline was January 15, 2007).

All published papers acknowledge the support received from this NSF-ATE project.

Dr. Tsou was also interviewed by the *Nature Magazine* reporter, Delcan Butler, with the discussion of Internet GIS in Butler's feature article, *The Web-Wide World* at the *Nature Magazine* in February 16, 2006.

Members of the team (including Eileen Goff, John Johnson, Ming Tsou and Anthony Howser) attended the 2006 ESRI International conference and the ESRI Education User Conference. In addition, Ms. Goff, Dr. Lee and Tony Howser attended the annual NSF Conference on October 18-19, 2006. Tony Howser made two poster presentations during the conference.

Eileen Goff presented the project at the League for Innovation in the Community College's Southern California College and Career Transitions Initiative Network Summit meeting in San Diego on March 26, 2007.

#### Year 2 Deliverables:

1. *Website makes courses available to students outside participating schools.* Web-based learning modules have been developed and are available on the website.
2. *Website describes the skills certification process.* This has not been completed, and will be addressed once the course descriptions have been reviewed through the curriculum approval process within the San Diego Community College District. This will be described on the Mesa College website in addition to the SDSU website.
3. *Conference presentations.* At least ten conference presentations have been completed to date.

## Project Issues

After the first year of implementation, the project evaluation reported two primary areas of concern in the project's progress in meeting its goals:

1. Limited progress in mapping the curriculum to the DACUM results, developing the project-based certification procedures, and identifying project-based curriculum needed to provide the skills certifications. The project had successfully identified the tasks and skills required for the GIS technician position through a DACUM process, but had faltered at the step of translating the DACUM results into community college curriculum, and determining how to then certify the skills and competencies identified in the DACUM to employers.
2. Focus of the web-based career awareness course modules. The project web site did not provide easy access GIS career awareness information. The web site contains web-based GIS exercises developed with specific high school partners. These GIS modules do not appear to be readily usable by teachers from schools other than those for whom the modules were developed.

The GIS program underwent several changes within Mesa College during the first year of implementation. The GIS program was moved from the Social Science division, where it was situated when the proposal was developed, to the Business, Computer Science and Technologies division. The Mesa College President decided that a full-time contract faculty position in GIS would not be created until there is sufficient student demand for the program courses to require (and justify) the addition of a full-time faculty member. At the end of the first year, there was only about 60% of the level of student demand needed to justify development of a full-time position in the program.

The College therefore began to investigate the possibility of developing student demand for GIS courses by integrating GIS modules within other, existing programs. Their research indicated that least seven Mesa College programs would find GIS curricula strongly applicable to the program, including anthropology, architecture, biology, computer business technology, computer and information sciences, marketing and social sciences. Several of these programs, including Computer Business Technology, Computer and Information Sciences, and Marketing are within the division that now houses the Mesa College GIS program. That combined with the strong support of tenured faculty in the Business, Computer Sciences and Technologies division proved to be a key positive factor in the project's second year of implementation.

The Year 1 Evaluation recommended that Mesa College: (1) add at least one more Co-PI from Mesa College to the project, (2) ensure that there are strong linkages between the project and the academic implementation of the GIS curriculum by having project staff who also teach GIS courses, (3) focus project attention on the development of the skills certification processes and GIS curriculum until they are completed; (4) develop a stand-alone GIS career awareness course on the project website; and (5) investigate the possibility of creating a Regional Occupational Program in GIS at the high school level; (6) identify the specific teacher training activities needed to prepare college faculty from across the curriculum and high school teachers to

incorporate GIS modules into their curriculum, and (7) ensure that all equipment and materials purchased with project funds are included in college and program inventories, and that their use is managed and controlled effectively to prevent loss.

Mesa College worked closely with NSF to make significant changes to the project staffing and reporting structures. Mesa College added two new Principal Investigators: Ms. Eileen Goff was named the Principal Investigator for the project, and Dr. Otto Lee became a Co-Principal Investigator. Dr. Lee provides the strong administrative leadership critical to successful project implementation within the College structure. Several additional project investigators who are experts in GIS, curriculum and program development were added to the project, and include John Johnson, Karen Owen and Karen Williams. In addition, several GIS adjunct professors starting working on the project on an hourly basis to contribute to the GIS curriculum review, analysis and development. These staff changes were completed in January 2006; Ms. Goff started working as the Principal Investigator in February 2006.

The Project Principal Investigators and participants made significant progress in getting this project back on track since February 2006. They have begun a systematic process of curriculum analysis and review that has resulted in the creation of a new GISG 104 course (which provides general education credit and can help attract new students to the program), a new GISG 114 course (Geodatabases) and revision of existing GISG courses. The process implemented also will facilitate development of skills certifications and articulation agreements. The career awareness website has been revised to address the original intent of the grant, and career learning modules were created and posted on the website. Training to prepare teachers to use these career learning modules has been created and was delivered to high school teachers in November 2006. Community college faculty members have begun implementing GIS into their courses, and a professional development workshop on incorporating GIS across the curriculum was offered in January 2007.

One concern arose during the March 2007 National Visiting Committee meeting. This meeting was attended by several high school teachers who had worked closely with SDSU during the first year of the project on the development of customized GIS modules for their classes. These teachers had received considerable one-on-one professional development through SDSU. Their enthusiasm for the help they had received and excitement about their work in teaching with GIS was infectious and motivated the entire group to discuss ways that this training could be expanded to more teachers and in more ways. However, it is critical to understand that extensive, one-on-one professional development for teachers was not part of the original intent of the project, which focuses on development of technician education and training in GIS. More focus on professional development may distract project staff members from the project's central goals and objectives.

## **Conclusions**

The goals of the project are to encourage underrepresented high school and community college students to pursue careers in GIS, and to provide a ladder of certification and education that enable students to work in GIS-related positions while pursuing further training and education.

The Consortium is developing GIS skills certifications, designed to meet industry and employer needs, that can be combined to provide an articulated educational program. These certificates build on each other and feed into an associate's degree in GIS for more comprehensive technical training, a bachelor's degree, and advanced degrees in the field.

The Consortium is developing a standards-based curriculum aligned across the three educational levels, including Web-based introductory programs in GIS to encourage students to pursue careers in the field and enhance enrollment in technician training and educational programs. The Co-PIs are creating articulation agreements that will ensure that students are able to progress efficiently through the skills certificate and more traditional educational programs, and are training college faculty and secondary school teachers to teach the introductory courses and use GIS materials in their classes.

The introductory courses envisioned solely for the high school level are the web-based career learning modules that have been developed during the second year of implementation. They are now available on the project webpage. Training workshops for high school teachers have been developed to focus on the integration and use of these learning modules in a wide variety of classes.

The Project Principal Investigators and participants have made significant progress in getting this project back on track in the past year:

- They have begun a systematic process of curriculum analysis and review that has resulted in the creation of a new GISG 104 course (which provides general education credit and can help attract new students to the program) and the revision or development of five other courses (GISG 110, 111, 112, 113 and 114) mapped to the DACUM results. The process implemented also will facilitate development of the skills certifications process and articulation agreements.
- The career awareness website has been revised to address the original intent of the grant, and career learning modules were created and posted on the website. Training to prepare teachers to use these career learning modules has been created and was delivered to high school teachers starting in November 2006.
- Community college faculty members have begun implementing GIS into their courses. A professional development workshop on incorporating GIS across the curriculum was offered in January 2007.

## **Recommendations**

1. Focus primarily on the development of the GIS curriculum and skills certifications until they are completed. This should include identification of the number of hours required for each course and certification (for other continuing education purposes) and the development of tracking mechanisms for students so that the number of certifications

awarded at each level can be monitored. Ensure that the GIS curriculum and skills certifications are mapped clearly to the DACUM results.

2. Develop institutional certification procedures for the skills certificates. It takes a long time to go through the SDCCD curriculum processes, so individual faculty members teaching the skills certification courses may need to sign the certifications in the beginning. The certifications processes must be institutionalized to have the level of significance to technician education and training that is expected from the project.
3. Investigate the possibility of offering the GISG 104 course to high school students, possibly as a Regional Occupational Program. This could enable high school students to get a head start into the GIS program at Mesa College, and encourage them to enroll at Mesa and complete the program. (This could open up new avenues of funding for the course at the high school level).
4. Ensure that the GIS career awareness modules are aligned to the California Content Standards. To do this, project staff should team with experienced secondary teachers to map the modules to the Standards, and document the process in writing. This process also should develop more thorough assessments of student learning in the online modules.
5. Focus on building a pipeline of students into the community college program by getting high school and college students interested in learning more about GIS and exploring its applications. This will be accomplished within the current grant through the career learning modules and the development of the community college curriculum and articulation agreements with SDSU. Be careful that the articulation agreements encourage students to attend Mesa College for technician education and training.
6. Focus teacher and faculty training on incorporating the GIS modules developed (and aligned to state standards) into their curriculum. This should focus on training teachers and faculty to implement the modules without intensive support from project staff.
7. Be careful of scope creep. The project has found that integrating GIS into a course appears to be too demanding for most faculty members to do without time allocated to learn to use GIS, professional development on integrating it into the curriculum, and technical support to use it in classes. However, extensive, one-on-one professional development for teachers was not part of the original intent of the project. Providing the extensive training and technical support needed to help faculty from a variety of disciplines integrate GIS applications into their courses and curriculum is beyond the scope of the project.

Developing the curriculum and certification procedures to educate technicians is the central purpose of the project. The project must focus on the key objectives and activities of the project if it is to stay on track and be concluded successfully.