**Annual Report for Period:** 10/2005 - 10/2006      **Submitted on:** 04/11/2006

**Principal Investigator:** Goff, Eileen D.      **Award ID:** 0401990

**Organization:** San Diego Mesa College

**Title:**

A Scalable Skills Certification Program in Geographic Information Systems (GIS)

## Project Participants

**Senior Personnel**

**Name:** Tsou, Ming-Hsiang

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Dr. Tsou is a co-PI on the Project. He is responsible for the SDSU sub-award and activities. He is the lead scientist for the development of the Web-based GIS career awareness program and the standard-based GIS curriculum at SDSU.

**Name:** Eckberg, Carl

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Dr. Eckberg is a co-PI on the Project. He is responsible for the development of GIS skill certificates, articulation, and the Web-based GIS Career awareness program.

**Name:** Johnson, John

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Mr. Johnson is a consulting GIS Specialist on the Project. He is a subject matter expert in the DACUM and curriculum development process and also plays a substantial role in the skills certificate development and the Mesa College student GIS Internship program.

**Name:** Goff, Eileen

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Ms. Goff is the PI of the Project and is Adjunct Faculty in GIS at Mesa College. She is responsible for day-to-day leadership on the Project, including coordination of project tasks, meetings, and Mesa College-specific activities.

**Name:** Lee, Otto

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Dr. Lee is a co-PI on the Project and is Dean of the School of Business, Computer Studies, and Technologies at Mesa College in which the Project is housed. He is responsible for much of the Mesa College administrative and budgetary oversight on the Project.

**Name:** Williams, Karen

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Professor Williams is Department Chair in the School of Business, Computer Studies, and Technologies at Mesa College and oversees the College's GIS program. In addition, she has experience in curriculum development and processes at the College.

**Name:** Owen, Karen

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Ms. Owen is an Associate Professor with the Multi-media program in the School of Business, Computer Studies, and Technologies at Mesa College. Like Professor Williams, she also has experience in curriculum development and processes at the College.

**Post-doc**

**Graduate Student**

> **Name:** Howser, Anthony
>
> **Worked for more than 160 Hours:**     Yes
>
> **Contribution to Project:**

Mr. Howser is a graduate student at SDSU Geography Department and the webmaster of this project.  He is responsible for the development of research websites and the Web-based GIS modules.

> **Name:** Dodson, Kimberly
>
> **Worked for more than 160 Hours:**     Yes
>
> **Contribution to Project:**

Ms. Dodson is a graduate student at SDSU Geography Department.  She is responsible for the development of GIS Day activities and the GIS Day web pages.

> **Name:** Arora, Gagan
>
> **Worked for more than 160 Hours:**     Yes
>
> **Contribution to Project:**

Mr. Arora is a graduate student at SDSU Computer Science Department and the technical programmer of this Project. He is responsible for the design of weblog services and Google earth learning modules.

**Undergraduate Student**

**Technician, Programmer**

**Other Participant**

> **Name:** Sensenig, Phyllis
>
> **Worked for more than 160 Hours:**     No
>
> **Contribution to Project:**

Dr. Sensenig is the program evaluator. During the 2005-2006 program year she did the following:

1. Provided (limited) advice and guidance to the Mesa College NSF ATE management team regarding the project design, proposal components, implementation plan and key activities and priorities.  Dr. Sensenig met with John Johnson, Principal Investigator, and Margie Fritch, cognizant administrator, in early March 2005 to help them plan the visiting committee agenda and review project progress. Dr. Sensenig reviewed the initial draft of the Year 1 annual report and provided input to the Co-PIs for that report. Dr. Sensenig also had numerous telephone conversations and emails with John Johnson throughout the year regarding project progress and concerns.

Dr. Sensenig met with Otto Lee at the beginning of the project year (October 24, 2005) to review the project design, goals and objectives, concerns about the project management and progress, and alternatives to strengthen the project implementation. Dr. Sensenig also met with Eileen Goff, PI, to review the project purposes and progress as she took on responsibility for the project leadership.

2. Provided guidance to the Mesa College NSF ATE management team in designing the evaluation data collection process and developing data collection tools.  Dr. Sensenig reviewed the evaluation data collection processes and steps with John Johnson, PI during the first year of the program, in April, 2005.  Dr. Sensenig then reviewed the evaluation data collection and processes with Eileen Goff, PI, in February 2006.

3. Conducted a mid-term evaluation of the NSF ATE project in March/April 2005.  For this mid-term evaluation, Dr. Sensenig attended the Visiting Committee meetings and then met with the 2005 NSF ATE Principal Investigator, Co-PIs, and the Mesa College Administrator to review project goals and objectives, activities undertaken to date, and project achievements to date.  Dr. Sensenig obtained additional information from the Co-PIs to prepare the mid-term evaluation report for Year 1 of the project, which was submitted to the Mesa College cognizant administrator and the NSF ATE Principal Investigator in April 2005.

Conducted a final evaluation of the NSF ATE Project in October 2005. Dr. Sensenig met with John Johnson, the 2005 NSF ATE Principal Investigator, Co-PI Ming Tsou at San Diego State University, and Mesa College cognizant Administrator Otto Lee to

review project goals and objectives, activities undertaken to date, and project achievements. Dr. Sensenig also interviewed Margie Fritch from Mesa College and Robert Atterbury, Director of School to Career Programs for the San Diego City Schools, as part of the evaluation information gathering process. Dr. Sensenig prepared a written report of the evaluation findings and sent them to the Co-PIs for their review, additional and corrections as needed for accuracy. Dr. Sensenig then made the changes she deemed necessary for accuracy and submitted the report to the Mesa College cognizant administrator (Otto Lee) and the 2005 NSF ATE Principal Investigator (John Johnson) in October 2005.

**Research Experience for Undergraduates**

## Organizational Partners

**High Tech High School**

High Tech High is a well funded, leading edge Charter School operating within the San Diego Unified School Distirct. It has partnered with us to help promote GIS in the High School curriculum. Dr. Jay Vavra, HTH's biotechnology teacher, is currently working with project staff to incorporate GIS into a project which maps the marine biology of San Diego Bay.

The Gary and Jerri-Ann Jacobs High Tech High Charter School is a bold innovation in public education. Launched in September 2000 by an industry and educator coalition, High Tech High (HTH) occupies a newly designed learning space at the former Naval Training Center (NTC) in San Diego. A small, diverse learning community with a current enrollment of 452 students, HTH is founded on three design principles: personalization, adult-world connection, and a common intellectual mission. Innovative features include performance-based assessment, commom planning time, state-of-the-art technical facilities for project-based learning, internships for all students, and close links to the high tech workplace.

**Helix Charter High School**

Helix Charter High School (7323 UNIVERSITY AVE.LA MESA, CA 91941)
operates outside of the San Diego Unified School District. Two of its teachers, Paula Ann Trevino and Garry Wilcox, are currently using GIS in their classrooms. Paula and Gary are interested in working with our project team to enhance their GIS activities and network with other teachers with similar ambitions.

Helix, located in a low to middle socio-economic community twelve miles east of the San Diego beaches, has a changing student body which reflects the rich ethnic diversity of California. Students of color comprise 41% of the total school population of 2,357, with 19% Hispanic, 14% African American, 4% Asian, and 4% other ethnicities. Twenty-five different languages can be heard on campus. Hearing impaired, Special Education, Title 1, and sheltered students participate in extra curricular programs like drama, cheer, choir, athletics, USA Club and Peer Mediation. Through our weekly Advisory Classes, staff members support their students and encourage them to be involved at Helix. One-third of the student body takes part in at least one athletic program.

**ESRI**

ESRI, a leading producer of GIS software has partnered with us on this project. Ann Johnson, an ESRI higher education manager, is on our National Visiting Committee and San Diego Mesa College and SDSU currently have ESRI College Site Licenses.

ESRI was founded as Environmental Systems Research Institute in 1969 as a privately held consulting firm that specialized in land use analysis projects. The worldwide headquarters of ESRI are anchored in a multicampus environment in Redlands, California, about a 2 hour drive from San Diego. Today, ESRI employs more than 2,900 staff, more than 1,500 of whom are based in Redlands, California, at the world headquarters. The company has revenues of more than $560 million and an annual growth rate of over 20 percent. ESRI software is used by more than 300,000 organizations worldwide including most U.S. federal agencies and national mapping agencies, 45 of the top 50 petroleum companies, all 50 U.S. state health departments, most forestry companies, and many others in dozens of industries.

ESRI software is the standard in state and local government and is used by more than 24,000 state and local governments including Paris, France; Los Angeles, California, USA; Beijing, China; and Kuwait City, Kuwait.

ESRI fosters relationships with more than 65 software, technology, data, hardware, system integrator, and consulting companies to ensure product compatibility and to explore new technologies. ESRI works closely with major technology partners such as SAP, Microsoft, SAS, IBM, FileNET, Sun Microsystems, Hewlett-Packard, and others.

Each year, more than 25,000 GIS professionals and students in the United States are trained by ESRI or ESRI-authorized instructors. In

addition, more than 11,000 individuals from 180 countries have enrolled in ESRI Virtual Campus Web-based training courses on the Internet, and approximately 50,000 students a year complete university courses taught with ESRI software.

**Herbert Hoover High School**

The co-PI, Dr. Tsou is collaborating with the Hoover High Teacher: Ellen Towers, Academy Coordinator/Teacher (etowers@sandi.net) to introduce the GIS technology and Career awareness in the Information Technology classes.

Hoover is one of sixteen High Schools in the San Diego Unified District, and is one of the oldest schools in the district. Hoover is located to the east of downtown San Diego and is attended by approximately 2,000 students. A faculty of about 80 instructs a very diverse student population in academic and extra curricular disciplines.

### Other Collaborators or Contacts

San Diego Regional GIS Council: This local GIS council serves as our project advisory committee and its members serve as 'subject matter experts' for our GIS curriculum.

Affiliated with the California GIS Council, the San Diego Regional GIS Council was formed to collaborate on the planning, implementation and maintenance of a California GIS infrastructure (the term 'infrastructure' is used here in a holistic sense to encompass systems, organizational programs, policy, standards, procedures, and any other factors that affect the ability of member organizations to jointly develop or acquire, share and maintain spatial data adequate to their needs). The San Diego Regional GIS Council is made up of local government agencies, water agencies, and state and federal agencies. They collaborate to acquire and share data, information and discuss GIS-related issues common to member agencies.

### Activities and Findings

**Research and Education Activities: (See PDF version submitted by PI at the end of the report)**

(See PDF version- [Project Activities] -- submitted by PI at the end of the report)

**Findings: (See PDF version submitted by PI at the end of the report)**

(See PDF version -- [Project Findings] -- submitted by PI at the end of the report)

**Training and Development:**

John Johnson as our DACUM developer, has received training on DACUM 'Developing a Curriculum', SCID 'Systematic Curriculum & Instructional Development' and ROI 'Performance based assessment & training analysis'

At SDSU, the major training task is to teach the graduate students advanced Web authoring technologies and Internet Map Servers (IMS). Dr. Tsou is responsible for this training for graduate students. By choosing the graduate students who already have strong background knowledge in Web authoring and IMS, our geography-major graduate students (Howser, Kimberly, and Chen) can immediately contribute to our project and only require minimum training and advice during the development of project Website and Web-based GIS modules. Two computer science graduate students (Li and Arora) are also capable of developing web-based GIS modules, but they will need more training in GIS technologies and Web-based mapping tools since they have only limited prior knowledge of GIS. The major Web-GIS technology training for our graduate students will be accomplished by the end of 2006.

**Outreach Activities:**

From April 1, 2005 to March 30, 2006, the SDSU Team conducted five high school GIS outreach activity events as the following:

1. 2005, September 28 (Wednesday). Dr. Tsou and Tony Howser visited Hoover high school with high school teacher Ellen Towers (etowers@sandi.net) to introduce the concept of GIS. The school developed an on-line mapping tool for their school project (the link between Obesity and Fast Food chain stores for overweight Students).

2. 2005, November. 16. GIS Day Activity. Dr. Tsou invited 120 Helix High school students to visit the GIS lab at San Diego State University

and learn the concepts of Web-based GIS, Google Earth, and GPS technologies.

3. 2005, November. 9-11 (Three days).  Dr.  Tsou visited the High Tech High school to have a one hour lecture on Wednesday, Thursday, and Friday (four classes)  to introduce the GIS technology to four classrooms (30 students each class, total: 120 students).

4. 2006, February 10 (Friday).  Dr. Tsou and Tony Howser visited Hoover high school (second time) with teacher Ellen Towers to introduce the concept of GIS. The SDSU team will develop a Google Earth-based GIS learning module for the students.

5. 2006, March 3 (Friday).  Dr. Tsou and Tony Howser introduced GIS and GPS technology to 120 Helix High school students at the SDSU GIS lab (CESAR lab).

Tony Howser also helped High Tech High teacher, Dr. Jay Varva with the book Perspectives of San Diego Bay: A Field Guide, by developing GIS maps and a GIS technology introduction.  The book has just been published. (Website: http://www.sdbayguide.com).

During the last year, the SDSU Team created one peer-review article, one book chapter, and two conference presentations with proceedings derived from this Project.  These articles, book chapters, and conference presentations create a strong outreach and share this GIS program with other institutes and communities in the U.S. and other counties, including Japan and Taiwan.

Conference Presentation and Proceeding:

1. 2005 ESRI International User conference: Ming-Hsiang Tsou and Antony Howser, Web-based and Mobile GIS for High School GIS career awareness. (http://gis.esri.com/library/userconf/educ05/abstracts/a1113.html )

2. 2006 AAG conference: Ming-Hsiang Tsou, 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)

## Journal Publications

Tsou, M.H., Guo, L., and Howser, T., "A Web-based Java Framework for Cross-Platform Mobile GIS and Remote Sensing Applications", GIScience & Remote Sensing, p. 333, vol. 42(4), (2005). Published

## Books or Other One-time Publications

Ming-Hsiang Tsou, "Book chapter: The Integration of Internet  GIS and Wireless Mobile GIS.", (2006). Book Chapter, Accepted
Editor(s): Marguerite Madden
Collection: Manual of GIS
Bibliography: published by the American Society for Photogrammetry and Remote Sensing (ASPRS)

## Web/Internet Site

**URL(s):**
http://geoinfo.sdsu.edu/hightech
**Description:**
Project Web Site and the Web Portal for High School GIS educators and the GIS Career Awareness Learning Modules.

## Other Specific Products

**Product Type:**
**Teaching aids**

**Product Description:**
Learning Module 1: Mapping Earthquake Magnitude & Plate Boundaries with ArcExplorer Java Edition for Education
**Sharing Information:**
Workshops, meetings, outreach activities

**Product Type:**
**Data or databases**
**Product Description:**
DACUM Chart for GIS Technician
**Sharing Information:**
Website, meetings, workshops, surveys

**Product Type:**
**Software (or netware)**
**Product Description:**
One Desktop GIS learning modules (CD-ROM and hard copy printout)
**Sharing Information:**
Workshops, Meetings, Outreach activities

**Product Type:**
**Teaching aids**
**Product Description:**
Learning Module 2: Population Learning Module (in Human Geography) for the Helix High School
**Sharing Information:**
Implemented on the Human Geography Class at the Helix High School.  Available on the project website.

**Product Type:**
**Teaching aids**
**Product Description:**
Seven new Internet Mapping tools (http://geoinfo.sdsu.edu/hightech/MapViewer/index.asp)
1. High Tech High: San Diego Bay Study Areas Map
2. High Tech High: San Diego Soils Map - John Horn for Scientific Project.
3. Hoover High: Obesity and Fast Food (Overweight Students)
4. Hoover High: Obesity and Fast Food (Unfit Students)
5. All High Schools:  World Earthquake Map for GIS Learning Module 1-Earthquake Chasers
6. All High Schools: Web-based Address Matching Tool
7. All High Schools: GPS to GIS coordinate conversion tool.
**Sharing Information:**
Websites, Workshops, Meetings, Outreach activities, including GIS and GPS exercises for high school students and their teachers

**Product Type:**
**Audio or video products**
**Product Description:**
SDSU Campus 3D movie (http://map.sdsu.edu/publications/01-sdsuTourMain_r1.wmv)
**Sharing Information:**
Website download. convert to CD-ROM and DVD format for distribution and sharing.

**Product Type:**
**Audio or video products**
**Product Description:**
2005 GIS Day movie (Introduction to Geospatial Technology). 15 minutes. (http://map.sdsu.edu/publications/GIS-day-movie-DVD.wmv)

**Sharing Information:**

Website download, converted to DVD and CD-ROM for distribution.


**Product Type:**

**Software (or netware)**

**Product Description:**

Weblog for High School Teacher (GeoBlog)
http://geoinfo.sdsu.edu/hightech/Wordpress/

**Sharing Information:**

High School Teachers can use this Weblog to share their own GIS education experiences. http://geoinfo.sdsu.edu/hightech/Wordpress/


## Contributions

**Contributions within Discipline:**

GIS education: We have completed a new DACUM Chart for GIS Technicians which identifies specific work-based competencies, analyzed by specific duties and tasks within these duties. The DACUM results will change the design of entry-level GIS courses in participating Community Colleges and Universities and may be adapted by others.

Geography Education: The development of Web-based GIS learning modules will have significant impacts for the future Geography Education in K-12 education plan. Traditional Geography courses (such as Human and Culture Geography, Physical Geography, and Map readings) will be transformed into more interactive and query-based learning materials.

The new development of a GE-level GIS course (Geographic Information Science and Spatial Reasoning) will become the first national model course for integrating multiple geospatial technologies and skills (by combining GIS, remote sensing, cartography, spatial statistics, and GPS technologies).


**Contributions to Other Disciplines:**

Educational Technology: The Project web site was designed to be a resource for educators seeking to incorporate GIS into their curriculum. Its effectiveness is indicated by the fact that our research website had 17,067 visitors during the last year. Comparing to the first year number, 6,650 unique visitors, our project website did growth its users by %256 during the second year.

This site contains multimedia, web-based learning modules and customizable web map viewers which provide new directions for the next generation of Educational Technology. This project demonstrates some new directions, including advanced client/server computing, distributed components, Java programming, and Web services technologies during the development of Web-based GIS learning modules.

The Project provides enhancements to High school education in biology and geology courses by creating two High School GIS learning modules:
1. Geography: Human Geography Population Module
2. Biology: San Diego Bay Marine Monitoring Study.
3. Geology: Earthquake Chaser module.

**Contributions to Human Resource Development:**

We are working with a group of San Diego High School Teachers to help them incorporate GIS into their curriculum. We are providing them with assistance in developing custom modules that enable them to teach with GIS.

**Contributions to Resources for Research and Education:**

We have developed a website which is used to introduce our project, disseminate on-line and desktop GIS learning modules, provide grounding in the fundamentals of GIS theory & concepts, help students assess their interest in and aptitude for GIS-related careers and form an on-line community and portal for GIS-education research and related projects.

**Contributions Beyond Science and Engineering:**

We are helping to expand the use of GIS in the San Diego region and beyond by (1) increasing the number of trained GIS technicians, (2)providing these students with internships, (3) increasing the number of teachers and students who use GIS as a tool for learning and exploration. These new GIS users will be critical thinkers with strong spatial reasoning abilities. They will be better able to interactively explore, analyze and make decisions about problems. This will contribute to an improved society with a more efficient use of its limited natural resources.

## Special Requirements

**Special reporting requirements:** None

**Change in Objectives or Scope:** None

**Unobligated funds:** less than 20 percent of current funds

**Animal, Human Subjects, Biohazards:** None

## Categories for which nothing is reported:

# Project  Activities

**Annual Report: 0401990**
**Annual Report for Period:** 10/2005 - 10/2006       **Submitted on:** 04/01/2006
**Principal Investigator:** Goff, Eileen       **Award ID:** 0401990
**Organization:** San Diego Mesa College
**Title:** A Scalable Skills Certification Program in Geographic Information Systems (GIS)

## GRANT ADMINISTRATION AND FACULTY ENGAGEMENT

San Diego Mesa College was in the midst of a transitional year during Year One of this grant. The Dean associated with the original proposal left the college.  Interim personnel also served in various other key leadership positions, including that of College President.  During the summer of 2005, the permanent personnel assumed all the previously interim positions and new President Rita Cepeda stated her strong commitment and support for this program.

Institutional instructional priorities did not permit the hiring of a full-time GIS faculty member during the Fall 2005 semester recruitment cycle; however, a full-time Geography faculty member was hired. Instead, Mesa College chose to use a team approach to ensure that the Project objectives highlighted are achieved.

Eileen Goff, one of Mesa College's GIS adjunct faculty members, assumed the role of PI.  Ms. Goff's subject matter expertise, combined with her project management skills and academic experience, bring a methodical and results-oriented approach to developing a successful skills-based certificate and curriculum model that integrates well into the high school-community college-four year university pipeline.  Ms. Goff has over 15 years of direct experience in the GIS field encompassing software applications, project management, and consulting services to various government clients.  She is the founder and president of her own GIS company, Geomorph Information Systems, and is an ESRI-authorized ArcGIS trainer.

Mesa College added three full-time, contract faculty members to the Project team.  Karen Williams is Chairperson of the Computer Business Technology Department, which houses the GIS program.  Karen Owen is a multi-media faculty member from the department.  Both Professor Williams and Owen have extensive experience managing grants and development of technology curriculum in areas such as multimedia and web design.  A new full-time Geography faculty member, Dr. Ken Berger, has joined the team to assist in the articulation of Geography/GIS courses with high schools and four-year institutions.  The three faculty members will be granted release time to assist part-time on the Project; their participation will accelerate the institutional integration of the GIS program through mechanisms such as the Academic Senate, Program Review, Professional Development, and other college functions.

By re-distributing project responsibilities, John Johnson, the previous PI, now dedicates his efforts to the certificate structure; outreach and working with industry on the internships and other experiential components of the curriculum; and recruiting additional GIS faculty members.  Mr. Johnson is designated as a subject matter Consultant to the Project.

At the recommendation of NSF, an additional Co-PI was added to oversee the administrative responsibilities for the grant.  Otto Lee, the Dean of the School of Business, Computer Studies,

and Technologies, where the GIS academic program is housed, assumed this role at the College. He provides the institutional resources and administrative oversight for the Project. which will ensure that the Project is embraced by the institutional community and that appropriate personnel such as curriculum development specialists, faculty from other disciplines, high school outreach coordinators, and others, participate. Dean Lee has extensive experience managing educational grants and developing technology-based academic programs.

## PROJECT ACTIVITIES

The major research goals for Year Two of this Project are to:

- Develop skills certificates (Objective 1)
- Develop a standards-based GIS curriculum (Objective 2)
- Create articulation agreements across the three educational levels (Objective 3)
- Prepare high school teachers to provide GIS skills training (Objective 4)
- Develop Web-based GIS career awareness program (Objective 5)
- Share model skills certificates and training programs with other institutions (Objective 6)

The following report will highlight the major activities in each objective during the last 12 months.

### Objective 1.  Develop skills certificates

As part of the Mesa College curriculum development process, we have also been examining potential points in the GIS program at which students can be rewarded with a certificate that will be meaningful to potential employers. The Mesa College Team, consisting of GIS faculty and Professors skilled in curriculum and certificate development, distinguishes between officially-sanctioned College certifications and unofficial certificates that would be under the purview of the School of Business, Computer Studies, and Technologies. These certificates could be awarded after one or more courses and after skill development in a very focused area such as GIS data editing, map design, or GIS data maintenance. These certificates will be in addition to those certifications already awarded in the Mesa College GIS program.

At SDSU, the current GIS certificate program has been revised to provide a stronger connection to the MESA College GIS certificate efforts. For the General Catalog (San Diego State University), under the "Geographic Information Science Certificate", the second paragraph is changed to:

> The certificate requires 27 units distributed between the Departments of Geography and Computer Science as follows: 12-15 units selected from Geography **104**, 381, 484, 581, 583, 584, 585, 587, 588 and 12-15 units selected from Computer Science 105, 107, 108, 220, 310, 320, 503, 514, 520, 535, 551, 575, 614A, 689. Courses with relevant content (Geography or Computer Science 596) may be substituted for the geography and computer science courses with the approval of the certificate adviser.

The new GEOG 104 course developed by Dr. Tsou has been added into the GIS Certificate Program at San Diego State University.  Two computer science courses (CS 537:  GIS Component Architecture, and CS 657: Spatial Databases) will be added into the GIS Certificate in the next year.

**Objective 2. Develop a standards-based GIS curriculum**

The focus of this objective is to develop a basic GIS curriculum, aligned across the three educational levels, designed to meet identified industry needs.

Mesa College has continued with the curriculum development process begun in Year One of this program. The first year focused on collaborating with local GIS Industry groups to develop a DACUM Research Chart for a GIS Technician position, which contains the duties and tasks identified as important components of an entry-level GIS position. This year's activities are focused on translating the DACUM Chart into actual GIS courses at Mesa College. Ultimately all tasks deemed to be essential for a GIS Technician will be taught in the GIS program, guaranteeing that a GIS Certification from the College will be of value to employers who require specific skills and/or require verification of a standards-based curriculum.

The SDSU team developed a new GEOG 104 (GE-level) course, which will be used for the articulation with the standards-based GIS curriculum at San Diego Mesa College and local High schools. Recently, GEOG 104 was approved by the University Senate in March 7, 2006 as the first General Education (GE) course in GIS to fulfill the requirement of Mathematics and Quantitative Reasoning Catalog. This is a significant accomplishment of this Project because this GE level GIS course will introduce the concepts and awareness of geospatial information technology to a broader scope of students and people beyond the traditional Geography-major students. This new GE course will be listed in the 2006-2007 General Catalog at San Diego State University.

The preliminary course website has been established (http://map.sdsu.edu/geog104). This new course will be taught by Dr. Tsou in Fall 2006. The design of GEOG 104 will use the DACUM result to revise the curriculum and learning objectives. One unique feature of the new GIS curriculum is to adopt Web-based GIS exercises rather than traditional desktop GIS training methods.

**Objective 3. Create articulation agreements across the three educational levels**

The goal of this objective is to create articulation agreements across the three educational levels to ensure that students are able to progress efficiently through the educational programs. Figure 1 illustrates the conceptual framework for the articulation agreements between San Diego State University, San Diego Mesa College and local high schools (Helix High).

At the High school level, Dr. Tsou is working with the Helix Charter High School teacher, Paula Trevino (Social Studies Department Chair) to develop a GIS course (GIS 1c/2c) for high school students. Once the course is established, we will be explore the possibility to create articulation agreement or AP credits between high schools, community colleges, and universities.
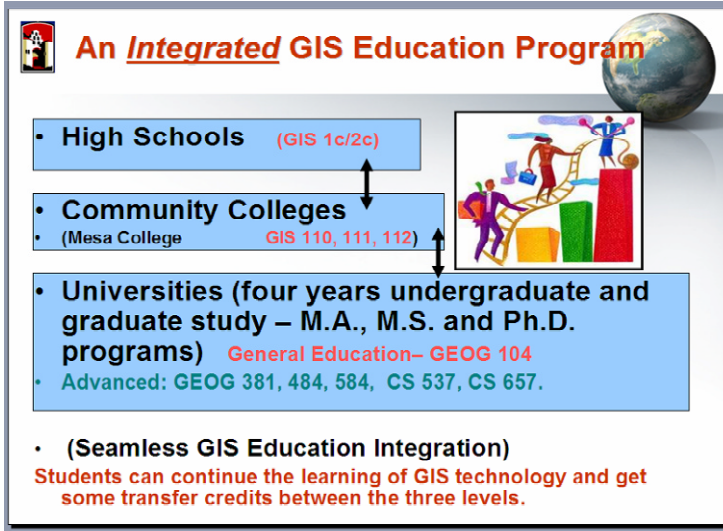
**Figure 1.** An Integrated GIS Education Program GIS course

The following is the draft course outlines for the High School (GIS 1c/2c)



**Figure 2.** The new GIS course (GIS 1c/2c) at High School level.

At the Community College Level, San Diego Mesa College is

At the University Level, the GEOG 104 course (Geographic Information Science and Spatial Reasoning) will be used for the major articulation course between SDSU and the community colleges. SDSU will also develop advanced GIS courses in both Department of Geography (GEOG 381, 484, 584, 684) and Department of Computer Science (CS 537 and 657) as the following:

- GEOG 381: Computerized Map Design
- GEOG 484: Introduction to GIS
- GEOG 584: GIS application

- GEOG 684: Advance GIS (seminar)
- CS 537: GIS Component Architecture
- CS 657: Spatial Databases

**Objective 4. Prepare high school teachers to provide GIS skills training**

The SDSU team is collaborating with three high schools (High Tech High, Helix High, and Hoover High) to introduce GIS technology and provide their teachers and students with training resources (books, websites, on-line mapping tools):

- Helix Charter High School: Teachers:
    - Paula Ann Trevino (social studies), M.Ed, Social Studies Department Chair, (patrevi@helixcharter.net)
    - Garry Wilcox (social studies) gwilcox@helixcharter.net

- High Tech High: Teachers:
    - Dr. Jay Vavra (bio) <jvavra@hightechhigh.org>
    - Rod Buenviaje (math) rbuenviaje@hightechhigh.org
    - Tom Fehrenbacher (humanities) tfehrenbacher@hightechhigh.org

- Hoover High: Teacher:
    - Ellen Towers, Academy Coordinator/Teacher (etowers@sandi.net)

From April 1, 2005 to March 30, 2006, the SDSU Team conducted five high school GIS outreach activity events as the following:

- 2005, September 28 (Wednesday). Dr. Tsou and Tony Howser visited Hoover high school with high school teacher Ellen Towers (etowers@sandi.net) to introduce the concept of GIS. The school developed an on-line mapping tool for their school project (the link between Obesity and Fast Food chain stores for overweight Students).
- 2005, November. 16. GIS Day Activity. Dr. Tsou invited 120 Helix High school students to visit the GIS lab at San Diego State University and learn the concepts of Web-based GIS, Google Earth, and GPS technologies.

- 2005, November. 9-11 (Three days). Dr. Tsou visited the High Tech High school to have a one hour lecture on Wednesday, Thursday, and Friday (four classes) to introduce the GIS technology to four classrooms (30 students each class, total: 120 students).

- 2006, February 10 (Friday). Dr. Tsou and Tony Howser visited Hoover high school (second time) with teacher Ellen Towers to introduce the concept of GIS. The SDSU team will develop a Google Earth-based GIS learning module for the students.

- 2006, March 3 (Friday). Dr. Tsou and Tony Howser introduced GIS and GPS technology to 120 Helix High school students at the SDSU GIS lab (CESAR lab).
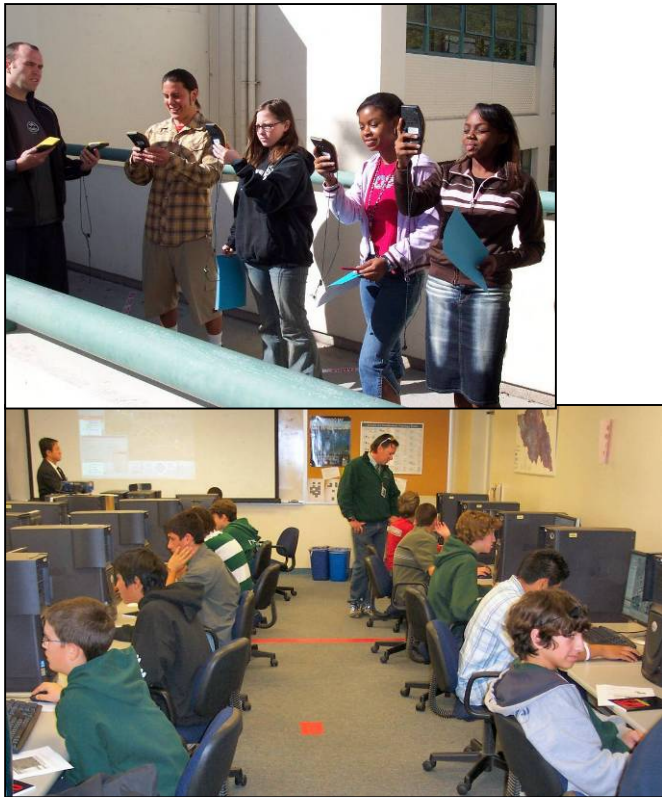
**Figure 3.** The GIS skill training and GPS introduction to High school students (Helix High visit on March 3, 2006).

Tony Howser also helped High Tech High teacher, Dr. Jay Varva with the book *Perspectives of San Diego Bay: A Field Guide*, by developing GIS maps and a GIS technology introduction. The book has just been published. (Website: http://www.sdbayguide.com).

**Objective 5. Develop Web-based GIS career awareness program**

This objective is to develop a Web-based GIS career awareness program to encourage students to pursue careers in the GIS field and enhance enrollment in GIS technician training and educational programs. In the second year, Dr. Tsou and Dr. Eckberg are working with three graduate students (Tony Howser, Kim Dodson, and Arora Gagan) to revise the research (Website: http://geoinfo.sdsu.edu) to focus on the GIS career awareness

The GIS career program and the research website are geared mainly for the high school audience. By combining multimedia presentation and advanced Web technologies (Flash animation, Online Video clips, and interactive Web mapping tools), the research website provides high school students and teachers with a grounding in fundamental GIS theory and concepts. The comprehensive GIS introductions and linked Web resources can help students assess their interest in and aptitude for GIS-related careers.

**Old version**

**New version**

**Figure 4.** The Revision process of the Research Website for hosting Web-based GIS career awareness program. (http://geoinfo.sdsu.edu/hightech).

Tony Howser is the system administrator of the Web server, a DELL PowerEdge Duel 1.4Ghz (Xeron Processors with 1G RAM) Web Server running Windows Server 2003 operating system. Tony is also the Webmaster of our research website. The Web Server is provided by the Department of Geography at San Diego State University and located in the Center for Earth Systems Analysis Research (CESAR).
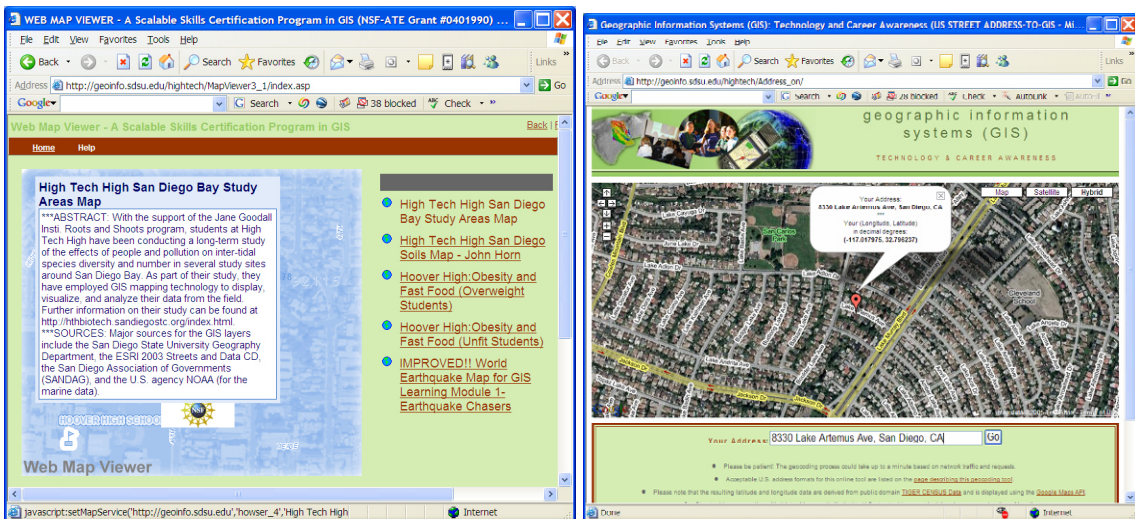


**Figure 5.** Web-based GIS Learning tools for High School Students.
http://geoinfo.sdsu.edu/hightech/MapViewer/viewer.asp

For Helix High school, the SDSU team created a series of Web-based population learning modules for two Human Geography courses with a total of 120 students. One of our previous SDSU Graduate Assistants, Jing-Yi Chen, developed these web-based modules for her Masters Thesis research topic: **The Implementation and Effectiveness of Web-based Geographical Information System (GIS) in High School Education**. In her research, she investigated the feasibility of Web-based geographic information system (GIS) adoption in high school education. Educators encounter many challenges while applying the standard desktop GIS. Web-based GIS is viewed as an alternative to overcome the barriers to the diffusion of GIS in education, including difficulties in maintaining hardware equipment and time limitations in learning software and developing teaching materials. The goal of this research is to address how effectively Web-based GIS can be used to assist high school education. Chen tested 120 students in March 2006 and compared the Web-GIS learning outcome (scores) to the previous year (non-Web GIS) in the same human geography course. The results of this testing will be analyzed for the Masters Thesis.

Tony Howser also developed several on-line mapping tools by using ArcIMS and JavaScript technology. He developed the following Web mapping modules:

- High Tech High: San Diego Bay Study Areas Map
- High Tech High: San Diego Soils Map - John Horn for Scientific Project.
- Hoover High: Obesity and Fast Food (Overweight Students)
- Hoover High: Obesity and Fast Food (Unfit Students)
- All High Schools: World Earthquake Map for GIS Learning Module 1-Earthquake Chasers
- All High Schools: Web-based Address Matching Tool
- All High Schools: GPS to GIS coordinate conversion tool.

One major task in Objective 5 is to develop a High School GIS Career Awareness program with certificates. The SDSU team designed a preliminary architecture for the High School GIS Career Awareness Program as the following:

1. Complete the learning module **ONE: Google Earth and Digital Data format** (introduce RS data, Vector data by using Google Earth).
2. Compete the learning module **TWO: Understanding various GIS applications in different fields** (homeland security, environmental protection, etc.)
3. Complete the learning module **THREE. Introduce the future of GIS**, Web-GIS, wireless mobile GIS and their impacts to our society in the 21st century.
4. Submit an **GIS Career essay** (three pages around 1000 words) about their learning results from three modules and their future GIS career plan.

If high school students can complete all four items (1-4), the Project team can issue a High School GIS Career Skill certificates to the students via on-line PDF files or on the paper format. The Web-based GIS career awareness program and GIS learning modules for high school students will be pilot-tested by high school teachers and students from High Tech High School and Helix Charter High School. Their comments will be used for future revision of the Web-based GIS career awareness program. This certificate program is under development now.

**Objective 6: Share model skills certificates and training programs with other institutions**

The major goal of objective 6 is to share information about the GIS skills certification program with other educational institutions and industry through websites and presentations at selected conferences.

In the second year, seven Web-based GIS learning modules are completed and published on our research website, which is available to high school students to learn foundational GIS concepts and theories remotely.   Our Website also describes the skills certification process at both Mesa College and San Diego State University and an update on the DACUM progress.  All meeting notes and basic GIS education linkages are provided on our research Websites.  This project web site also includes several video clips (created by Dr. Tsou) and PowerPoint slides for o download and viewing.



**Figure 6.** The adoption of Multimedia GIS presentation (movies) for High school GIS awareness program.

During the last year, the SDSU Team created one peer-review article, one book chapter, and two conference presentations with proceedings derived from this Project.  These articles, book chapters, and conference presentations create a strong outreach and share this GIS program with other institutes and communities in the U.S. and other counties, including Japan and Taiwan.

**Conference Presentation and Proceeding:**

- **2005 ESRI International User conference: Ming-Hsiang Tsou and Antony Howser,** Web-based and Mobile GIS for High School GIS career awareness. (http://gis.esri.com/library/userconf/educ05/abstracts/a1113.html )

- **2006 AAG conference: Ming-Hsiang Tsou,** 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)

**Peer Review Journal Article:**

- **Tsou, M.H., Guo, L., and Howser, T. (2006).** A Web-based Java Framework for Cross-Platform Mobile GIS and Remote Sensing Applications. *GIScience & Remote Sensing. 42(4). Pp. 333-357.*

**Book chapter:**

- **Ming-Hsiang Tsou,** (Accepted). 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 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 (Figure 7).



**Figure 7.** The *Nature* article about Internet GIS and Google Earth. (Delcan Butler, The Web-Wide World, *Nature, vol. 439, Feb. 16, 2006.*

Dr. Tsou was invited to participate in the future planning of a National Geospatial Technology Resource Center, proposed by Ms. Deidre Sullivan at MATE Center, Monterey Peninsula College.

The SDSU team is also collaborating with another NSF-ATE project around the San Diego Regions, a new NSF-ATE grant (2006) to develop a GIS program at Southwestern College (SWC) with their faculty: Ken Yanow and Erin Browder, Southwestern College. The two NSF-ATE projects will work together in exchange experiences and share the research findings, especially in the development of the GEOG 104 curriculum.

Finally, the SDSU team conducted a detailed website usage analysis to analyze how many users access or download information from our project website (http://geoinfo.sdsu.edu/hightech). We conducted the web logs analysis from March 12, 2005 to March 15, 2006. During this year, our research website had **17,067** visitors from **3559** unique IP address (unique computers or PCs).

Figure 8. illustrates the numbers of total visitors by each month and the major statistic numbers for the project website.



**Figure 8.** The Web log Analysis (NSF-ATE Project website).
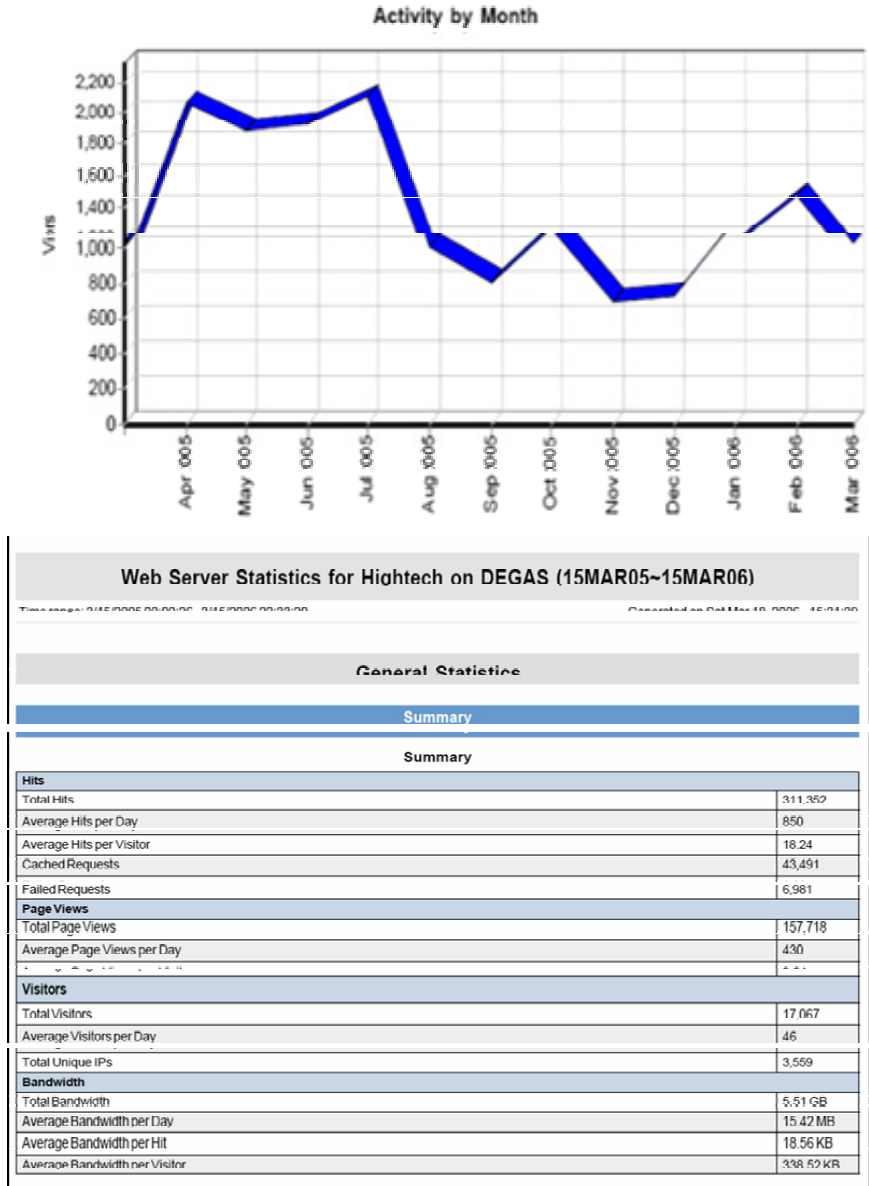
Figure 9 illustrates the major domains and countries to access this website. Besides the commercial and education networks, the Netherlands is the second largest user group (68 visitors during this year). Figure 10 illustrates the type of Web browsers to access our research site. Microsoft Internet Explorer 6.X is the most popular browser (%57.85 of total users).

**Top-Level Domains**

|  | Domain | Description | Hits | Visitors | % of Total Visitors | Bandwidth (KB) |
|---|---|---|---|---|---|---|
| 1 | .com | Commercial | 99,671 | 12,809 | 75.05% | 2,014,554 |
| 2 | | Unknown | 64,875 | 1,732 | 10.15% | 902,935 |
| 3 | .net | Network | 120,414 | 1,652 | 9.68% | 2,143,824 |
| 4 | .edu | Educational | 10,978 | 263 | 1.54% | 306,235 |
| 5 | .nl | Netherlands | 367 | 68 | 0.40% | 4,420 |
| 6 | .org | Non-profit Organization | 2,805 | 60 | 0.35% | 229,774 |
| 7 | .us | United States | 2,727 | 58 | 0.34% | 51,088 |
| 8 | .mil | Military | 1,041 | 47 | 0.28% | 12,148 |
| 9 | .ca | Canada | 757 | 47 | 0.28% | 18,401 |
| 10 | .gov | Government | 859 | 40 | 0.23% | 12,763 |
| 11 | .cz | Czechia | 1,215 | 32 | 0.19% | 20,553 |
| 12 | .de | Germany | 82 | 24 | 0.14% | 970 |
| 13 | .au | Australia | 493 | 22 | 0.13% | 7,383 |
| 14 | .uk | United Kingdom | 340 | 17 | 0.10% | 5,202 |
| 15 | .jp | Japan | 76 | 15 | 0.09% | 603 |
| 16 | .sa | Saudi Arabia | 54 | 14 | 0.08% | 274 |
| 17 | .ro | Romania | 385 | 14 | 0.08% | 4,601 |
| 18 | .in | India | 192 | 10 | 0.06% | 1,199 |
| 19 | .gbl | Unknown | 11 | 9 | 0.05% | 47 |
| 20 | .ie | Ireland | 216 | 9 | 0.05% | 564 |
| 21 | .tw | Taiwan | 291 | 8 | 0.05% | 4,727 |
| 22 | .cy | Cyprus | 146 | 6 | 0.04% | 547 |
| 23 | .za | South Africa | 110 | 6 | 0.04% | 956 |

**Figure 9.** The user distribution.

**Most Used Browsers**

|  | Browser | Hits | Visitors | % of Total Visitors |
|---|---|---|---|---|
| 1 | Internet Explorer 6.x | 155,913 | 3,102 | 67.85% |
| 2 | Firefox | 10,594 | 382 | 8.36% |
| 3 | Internet Explorer 5.x | 3,602 | 133 | 2.91% |
| 4 | Netscape 4.x | 634 | 132 | 2.89% |
| 5 | PubSub-RSS-Reader/1.1 (http://www.pubsub.com/) | 130 | 130 | 2.84% |
| 6 | Mozilla/4.0 (compatible;) | 370 | 127 | 2.78% |
| 7 | Safari | 2,647 | 78 | 1.71% |
| 8 | Others | 104 | 52 | 1.14% |
| 9 | Java/1.4.1_04 | 931 | 50 | 1.09% |
| 10 | NG/2.0 | 53 | 46 | 1.01% |

**Figure 10.** Web Browser types.

To facilitate the creation of an on-line community for GIS education, the SDSU team also created two online services for GIS educators. The first is the creation of GeoBlog to provide free Weblog functions for high school teachers to share their teaching experiences (Figure 11).

**Figure 11.** The creation of Geo Weblogs for GIS educators.

# Project Findings

**Annual Report: 0401990**

**Annual Report for Period:** 10/2005 - 10/2006      **Submitted on:** 04/01/2006

**Principal Investigator:** Goff, Eileen      **Award ID:** 0401990

**Organization:** San Diego Mesa College

**Title:** A Scalable Skills Certification Program in Geographic Information Systems (GIS)

## Objective 1. Develop skills certificates

While developing a new GIS curriculum, the Mesa College staff is also examining ways to develop and deliver skills certificates that are meaningful to potential employers. We have found that a team approach provides the best opportunities for success. The Team consists of five GIS subject matter experts (with a broad range of experiences in and knowledge of GIS) and two College Professors who both have backgrounds in curriculum and certification development. In addition to using a skilled group of experts to design the skills certificates, the Team also values a relationship with GIS Industry experts. These are the individuals who will ultimately determine whether particular certificates are important to their organization and enhance hiring opportunities for our students. Therefore, Industry experts also play a critical role in the verification of these certificates.

We found that it is important to create a strong connection between the Community College level GIS skill certificate and the University level of GIS skill certificate. At San Diego State University, the GIS certificate program is aiming for the training of GIS Analysts, Geospatial Database Developers, and GIS managers. At San Diego Mesa College, the GIS skills certificates program focuses mainly on the training of GIS technicians and entry-level GIS information specialists. The two different GIS skill certificate programs have one overlapped course (GEOG 104), which adopted a GIS curriculum developed by this project. This will create a strong connection between SDSU and Mesa College GIS certificates and provide a career ladder for the training of GIS professionals.

## Objective 2. Develop a standards-based GIS curriculum

The Mesa College Team has undertaken the translating or mapping of the DACUM Chart duties and tasks into a revised curriculum at the College. This new curriculum, constructed from those tasks identified by regional GIS professionals as being of greatest importance and/or most commonly performed by entry-level GIS staff, will address Industry needs and help to assure that our students can successfully secure employment in this field. It is important that we continue to confer with Industry so that we provide the skilled workers needed but also so that we are assured of delivering a GIS training program that is recognized and valued by Industry.

As we indicated in last year's report, it is a major challenge to create a standards-based GIS curriculum that is aligned across all three educational levels (high school, community college, and University). During the creation of the GEOG 104 course at San Diego State University, the major problem is to match the contents and teaching methods between Mesa College, high schools, and San Diego State University. One possible way to implement a basic GIS curriculum spanning all three educational levels is to create Web-based GIS courses with on-line computer lab exercises that can be shared by all three levels of students and educators. Web-based GIS

curriculum can provide flexible access and adoption for high school computer labs, which usually do not have GIS software available.

**Object 3.  Create articulation agreements across the three educational levels.**

Similar to previous discussion, we found that the articulation agreements will require strong support from the administrators across the three educational levels, including the high school principles, the community college Dean, and the department Chair of Geography at University level.  It is very important to maintain a good relationship between the research group and the administrators to facilitate the creation of articulation agreement.

**Objective 4.  Prepare high school teachers to provide GIS skills training**

We found that high school teachers need organized, hands-on GIS training when they are interested in teaching GIS or adopting GIS technologies for their curriculum.  Most high school teachers are not familiar with the concepts of GIS and do not have sufficient training in GIS software and hardware.  It is a critical component in this project to create several GIS training workshops specifically designed for high school teachers.  These training modules should adopt both desktop GIS (ArcGIS) and web-based GIS tools (ArcIMS and ArcExplorer). We also proposed two Phases in GIS education for high schools.

- Phase I – teach with GIS:  Using GIS to help existing courses (biology, human geography, information technology, etc.) and teachers' needs.
- Phase II -- teach about GIS:  Officially introduce the theories and technologies of GIScience

We are currently examining GIS training possibilities in the summer of 2006 for a pre-selected group of interested teachers: those who participated in the summer 2005 GIS workshops and expressed an interest in GIS training; those in schools where principals and other high-level administrators wish to introduce the technology; and/or those who wish to form a hub GIS group at their schools, developing GIS teaching expertise and serving to disseminate this knowledge to their fellow teachers.

**Objective 5.  Develop Web-based GIS career awareness program**

We found that it is important to integrate new technologies and multimedia GIS for attracting the new generation of students.  Animated movies, Google Earth, and flash animations can facilitate the learning of GIS for high school students and also attract the attention of young people. We are currently developing career awareness activities for the website, incorporating video and demos and planning participatory activities to which students can contribute and also interact with one another.

**Objective 6: Share model skills certificates and training programs with other institutions.**

The Project website is still an effective tool to share our project information and model curriculum with other researchers.  According to the Web log analysis, from March 15, 2006 to March 15, 2006, our project website attracted 17,067 visitors in total, with 3559 unique IP-address.  We have various users from more than 50 different countries, including the Netherlands, Japan, Germany, Canada, etc.

It is also very important to evaluate the effectiveness of Web-based GIS leaning modules. Currently, we are conducting research in collaboration with Helix High School to investigate the feasibility of Web-based geographic information system (GIS) adoption in high school education. Educators encounter many challenges while applying the standard desktop GIS. Web-based GIS is viewed as an alternative to overcome barriers to the diffusion of GIS in education, including difficulties in maintaining hardware equipment and time limitations in learning software and developing teaching materials. The goal of this research is to address how effectively Web-based GIS can be used in high schools.

**Summary of the National Visiting Committee meeting, March 30, 2006.**

The National Visiting Committee (NVC) recently met with faculty and staff of Mesa College, SDSU, and three San Diego High Schools to discuss and review the project. In their committee report of April 8, 2006, the NVC stated they were "*encouraged with the progress made by program personnel since our last meeting and the new organizational structure and team approach…. we feel more confident than ever that the Grant will serve as a model for others across the country*".

The NVC concluded their report by stating they were encouraged about the future success of the NSF project. Results of the NVC report findings are summarized below.



**Figure 12**.  The National Visiting Committee Meeting on March 30, 2006.

<u>**Achievements**</u>
- Reorganization is promising and encouraging – new team approach, distributed task responsibilities, effective high level leadership (including support from President, Vice President of Instruction, and Dean)
- The curriculum development process at Mesa College is well supported by the SCID model
- Development and acceptance of SDSU lower division GE course – this will be an important model for many other universities and colleges

- SDSU outreach to High Schools, grad student mentoring seems to be successful, for example support given to High Tech High's development of the beautifully-produced 226 page field guide on San Diego Bay and its environs, and development of web-based GIS to resolve lack of technology resources and support
- Networking seems to be leading to effective collaborative activities, especially with a number of high schools and their motivated teachers
- Outreach efforts of other Mesa College faculty are being initiated

## Opportunity
- Consider how an ongoing student mentor program can be developed to support high school teachers, such as making it a capstone project in degree programs
- UCGIS Geographic Information Science and Technology Body of Knowledge 2006 can provide an important resource for curriculum development
- For future qualification as GIS Professionals, ensure that contact hours are recorded for all course descriptions (see GISCI)

## Concerns
- Are K-12 teacher workshops part of this project? If not, find a way to do it. How does this affect articulation between high school and others? Consider a related grant or make use of existing campus programs
- Disconnect between SDSU activities and college activities, need to develop a org chart/road map to ensure strong links
- Publication of results in appropriate venue for all levels of educators
- What is the evaluation plan?
- What is the progress on the career path component?

## Things to do
- Carry through on articulation of SDSU's course to high school and college levels
- Create a brief timetable showing goals included in proposal, what has been done, what is in progress, anticipated completion dates, and responsible parties
- Publicize DACUM and SCID process – presentation and articles about the process and results
- Continue to publicize achievements of the project, including the new GE course
- Ensure that adjunct faculty have incentives to participate in the SCID process
- Ideas
- Teacher workshops need professional development credits
- Teacher workshops must not be one-size fits all
- Include IT participants in workshops
- Articulation needs to be across disciplines not just between academic levels