CALIFORNIA COMMUNITY COLLEGE'S GEOSPATIAL PROGRAMS

A Model Certificate for Geospatial Technology Program Development Aligned to Industry Needs

Final Report

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Executive Summary

This project, the California Community College Geospatial Project: *A Model Certificate for Geospatial Technology Programs* was tasked with researching ways that California Community Colleges can help prepare students entering or updating their skills to meet the needs of the geospatial industry. It was also tasked to investigate whether awarding badges based on industry validated skills and competencies would be of benefit to students, colleges and industry.

Questions Under Study

Some of the specific questions the project proposed to study to support geospatial technology programs include:

1. *Is there a need for a California Community College Model Certificate that provides guidelines in developing or expanding industry-validated geospatial programs?*
2. *Can the Model Certificates and Courses be used to create a transferable area of emphasis of at least 18 transferable units under SB 1440 - The Student Transfer Achievement Reform Act (STAR)*
3. *How can California Community College geospatial programs meet the needs of the industry and not impact college budgets significantly, or increase faculty work load?*
4. *How are geospatial courses and program offerings justified and sustainable under the emerging requirements for accountability both from the college point of view (completion rates) and student view (evidence of acquired skills)? Can that evidence be in the form of micro-credentials (badges)?*

Methodology

- Research on the web and in documents related to community colleges and geospatial education;
- Creation of two panels of geospatial experts to serve as advisors on important questions;
- Surveys of the expert panel members on topics needing clarification;
- Face-to-face and teleconference meetings with the Educator Panel to review findings of surveys and discuss current geospatial program needs, issues and suggest recommendations;
- Teleconference meetings with the Industry Panel;
- Contact other organizations and institutions to review innovative ways to document student success and program completion; and
- Review of draft final report and recommendations by the Panels and incorporation of edits, suggestions and comments.

Recommendations

The following Recommendations and Next Steps are summarized outcomes from research carried out as part of this project.

1. Adopt the Model Courses and Certificate Guidelines for Core and Electives based on industry validated skills and competencies and educator input to serve as a Model set of guidelines for California Community Colleges. Pilot test the model with programs needing to update their programs.

2. Investigate creating a Geospatial Technology transfer program (SB 1440) based on the Model Courses and Certificate. Create a common numbering system for geospatial technology. Work with all stakeholders to overcome barriers to create a core of geospatial technology (18 unites) as a Model Transfer program for Geospatial Science and Technology.

3. Create a Consortium to provide infrastructure to support course sharing, student tracking and documentation of program and student success. Provide professional development for faculty needing to update their skills and competencies in emerging technology.

4. Develop a pilot project to create badges through infrastructure developed by Purdue University and the Mozilla Foundation starting with those badges suggested by the panels. Investigate other options for hosting and awarding badges including working with professional organizations and industry.

Introduction

The mission and vision of the California Community Colleges provides an excellent example to other college systems of how two-year colleges can meet the needs of a diverse student population. The California Community College Chancellor's office states on its website that:

> Our colleges provide students with the knowledge and background necessary to compete in today's economy. With a wide range of educational offerings, the colleges provide workforce training, basic courses in English and math, certificate and degree programs and preparation for transfer to four-year institutions.

This multifaceted mission has served California well, but the Chancellor's office also states that:

> "With baby boomers retiring as the best educated and most skilled workforce in U.S. history, labor experts are concerned that California will lack workers with the critical aptitude needed to replace them" (California Community Colleges Chancellor's Office, 2012)

This concern is particularly true for the geospatial technology workforce and industry. Geospatial technology, which includes Geographic Information Systems (GIS), remote sensing, Global Positioning Systems (GPS) and other location-based technologies, has become an essential tools in many professions. It is used in such diverse fields as urban planning, public safety and emergency response, healthcare, energy and business. Los Angeles County spends over $20 million per year on the technology, and in 2012, the LA Board of Supervisors, recognizing the importance of specific skills needed to best use the technology, created eight new occupational categories to better define and reward employees with the needed skills (Greninger, 2012).

Geospatial technology has been identified by the US Department of Labor as an important emerging field with a projected job growth for geospatial occupations of 3 to 29 percent between 2010 to 2020 (O*Net.gov, 2012). Professional job placement services have suggested that the employment outlook is bright with increasing employment opportunities across the US in 2013 and beyond (Serby, 2012).

This project, the California Community College Geospatial Project: *A Model Certificate for Geospatial Technology Programs* was tasked with researching ways that California Community Colleges can help prepare students entering or updating their skills to meet the needs of the geospatial industry. It was also tasked to investigate whether awarding badges based on industry validated skills and competencies would be of benefit to students, colleges and industry.

Section 1 – Project Objectives

Some of the specific questions the project proposed to study to support geospatial technology programs include:

5. *Is there a need for a California Community College Model Certificate that provides guidelines in developing or expanding industry-validated geospatial programs?*
6. *Can the Model Certificates and Courses be used to create a transferable area of emphasis of at least 18 transferable units under SB 1440 - The Student Transfer Achievement Reform Act (STAR)*
7. *How can California Community College geospatial programs meet the needs of the industry and not impact college budgets significantly, or increase faculty work load?*
8. *How are geospatial program and course offerings justified and sustainable under the emerging requirements for accountability, both from the college point of view (completion rates) and student view (evidence of acquired skills)? Can that evidence be in the form of micro-credentials (badges)?*

This report will address these questions and describe the methods used to research, define and validate recommendations and implementation options. In this report we will use the term badges and micro-credentials interchangeably, but the term "badges" is currently used by most organizations and educational institutions.

Section 2 – Project Study Methods

The methods used were:

- Research on the web and in documents related to community colleges and geospatial education;
- Creation of two panels of geospatial experts to serve as advisors on important questions;
- Surveys of the expert panel members on topics needing clarification;
- Face-to-face and teleconference meetings with the Educator Panel to review findings of surveys and discuss current geospatial program needs, issues and suggest recommendations;
- Teleconference meetings with the Industry Panel;
- Contact other organizations and institutions to review innovative ways to document student success and program completion; and
- Review of draft final report and recommendations by the Panels and incorporation of edits, suggestions and comments.

Section 2.1 – Expert Panels

Participants were contacted and two expert panels were formed to represent both industry and academia.

- An Industry Panel of 14 expert geospatial users from local, county, state and federal government, geospatial organizations and private industry

1. David DiBiase – Director of Education Esri - GISP
2. Fred Dominguez – Epidemiologist, LA County Health
3. Nick Franchino – GIS Manager, LA County Dept. Regional Planning
4. Eileen Goff – GIS Specialist, President GeoMorphis - GISP
5. Mark Greninger – GIO, CIO Los Angeles County, CGIA Board
6. David Hanson – GIS Specialist Bureau of Reclamation- GISP
7. Ruth Ann Harbison – GIS Coordinator, Merced - GISP and CGIA Chair
8. Bill Hodge – GIS Division Manager - Midland Texas – GISP, Vice President GISCI
9. Ed Lamas – IS Analyst II, LA County Fire Department
10. Nathan Ong – Research & Development Unit LA Police Dept.
11. David Peck – Pictometry, Vice-Chair CGIA
12. Timothy Smith – GIS Manager, Los Angeles Fire Department
13. Emilio Solano – Chief Cadastral Engineer, LA County Assessor
14. Linda Wright – GIS Analyst II El Dorado County - GISP

- An Educator Panel of 15 California Community College educators who have created or teach in a geospatial program at a California Community College. One administrator, John Mummer from Foothill College, although not officially on the panel provided input by participating in one webinar.

1. Wing Cheung – Palomar College - GISP
2. Chris Cruz – West Valley College
3. Richard Della Valle – Napa Valley College
4. Les Doak – Cypress College
5. Vanessa Engstrom – San Bernardino College
6. Arlene Guest – Monterey Peninsula College
7. Hugh Howard – American River College
8. Allison Lenkeit Meezan – Foothill College - GISP
9. Nancy Miller – Lucia Mar Unified School District
10. Warren Roberts – Rio Hondo College – Served as Host for face-to-face meeting and Team Advisor.
11. Dan Scollon – Shasta College
12. Mono Simone – City College of San Francisco
13. Binita Sinha – Diablo Valley College - GISP
14. Deirdre Sullivan – Monterey Peninsula College
15. Adrian Youhana – Pierce College

A Survey was created for the Industry Panel and for the Educator Panel. Each Panel member completed the detailed survey using Survey Monkey (survey results, Appendix B) to capture their expertise related to the needs of industry or education including comments regarding the value of a model certificate, component model certificate courses and badges.

The questions related to Model Courses and Certificate or industry validated competencies were based on the work of the National Science Foundation funded GeoTech Center (DUE #0801893) and the Department of Labor's new Geospatial Technology Competency Model (GTCM). See

complete details about how the Models and GTCM and competencies were developed at the GeoTech Center website (www.geotechcenter.org). Also included in Appendix A is the Model Course spreadsheet listing all of the Model Courses and competencies grouped into twelve clusters.

Each Panel also participated in two webinars where they were presented with the results of the surveys and discussed ongoing findings by the research team. Participants then commented on findings and made recommendations. The Educator Panel also met face-to-face on October 11-12, 2012 for an in depth working meeting in Ontario, California, where each of the questions and findings were presented, debated and recommendations formulated.

Section 2.2 – Research Team

The Research Team was managed by Perla Fickenscher, Director at the Los Angeles/Orange County Environmental Training Center and included Ann Johnson and Christine Lewis. Ann Johnson created a geospatial certificate program for San Bernardino Valley College in 1998, taught at community colleges in California and was higher education manager for Esri (a major geospatial software company) for 13 years. She and Christine Lewis also managed and taught professional development workshops under California Community College Geospatial Information Support (C3GIS.net) for more than 125 faculty. Christine Lewis developed geospatial curriculum for Butte Community College in 1996, where she also taught for several years. She worked for seven years in the Water Distribution and Hydropower Industry and is currently an Adjunct Professor at CSU, Chico. She also has worked on numerous geospatial education grants.

The team, as part of their research, investigated what other educational institutions and organizations are doing related to badges including Yale, Purdue, MIT, Carnegie-Mellon and the Mozilla Foundation and McArthur Foundation. Conference calls were made by the Team with the Mozilla Foundation's Open Badges project to learn more about creating badges and infrastructure to support them. Additional research was conducted via the Internet, review of video interviews online such as between Stanford President John Hennessy and Salman Khan of Khan Academy (Gannes, May 31, 2012). The Mozilla Foundation and McArthur Foundation are working with Purdue University to set up a beta test site for creation and awarding of badges. The Team is investigating how it could participate in the Purdue Beta initiative (Purdue).

Section 3 – Questions and Recommendations

Section 3.1 – Question 1: *Is there a need for a California Community College Model Certificate that provides guidelines in developing or expanding industry-validated geospatial programs*?

The answer to this question provided by the Panel participants was based on the outcomes from the surveys, webinars and the discussions during the face-to-face workshop and was overwhelmingly positive. When most geospatial programs at community colleges were developed, there were no guidelines or standards on which to build a geospatial program. Each campus developed its own program ranging from one course to full Associate Degree programs and certificates had a wide range of units required for completion. Students had no way to

evaluate which program would best meet their needs. And without guidelines as to course content, students couldn't easily transfer courses between colleges or universities. With the adoption of a model certificate program with common guidelines, these issues would be resolved.

As another component to this question, both panel's members were asked "If you were going to design a model curriculum with three to five CORE courses, what would they be"? Both educators and industry panels were in close agreement with the same five courses getting a majority of the votes.

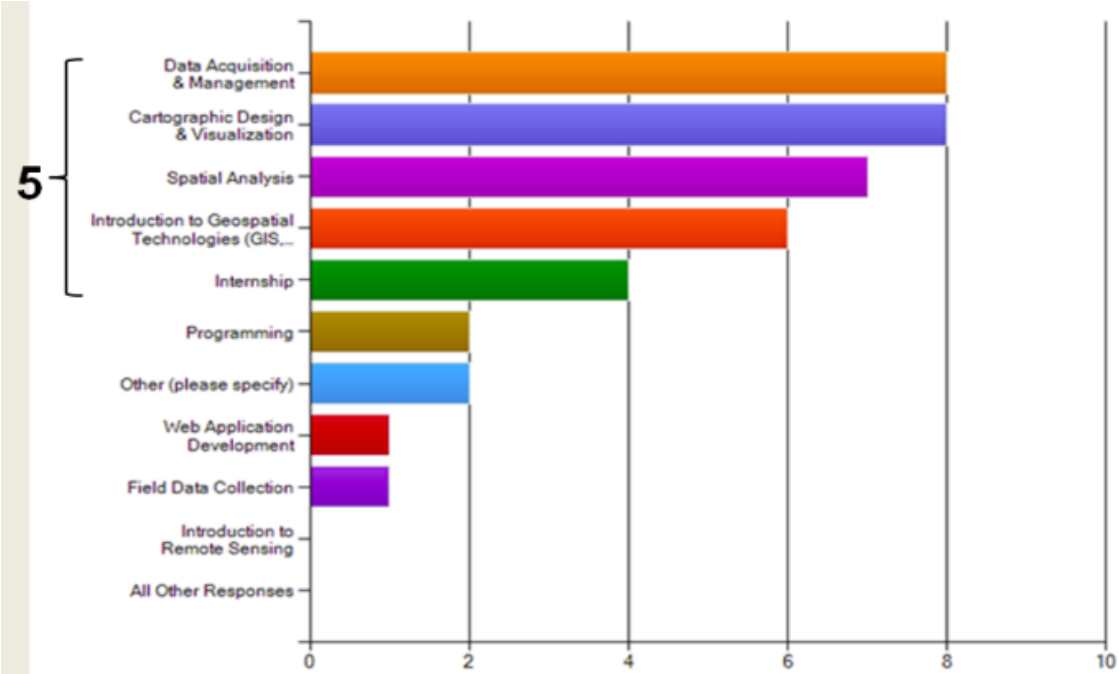

Figure 1: Industry Panel

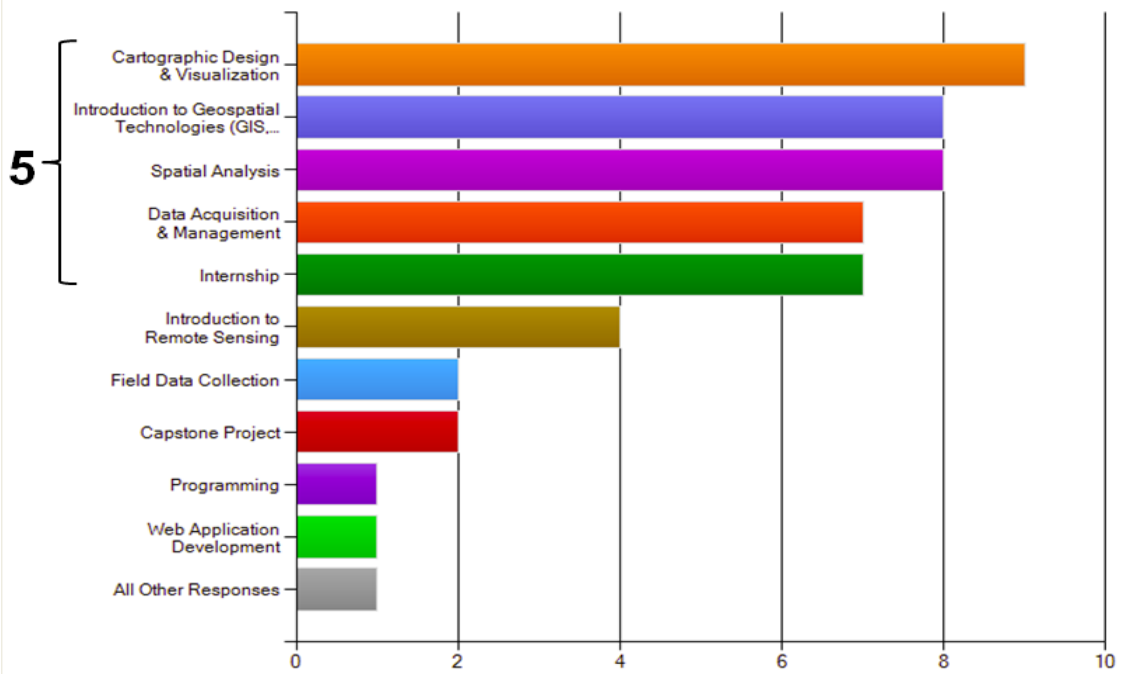

Figure 2: Educator Panel

Further discussion at our face-to-face and post-survey webinars recommended:

- The core would include five courses
  - Four courses in a lecture and lab format earning 3 units each
  - An Internship course earning between 1 to 3 units
  - All course names are suggestions and may need to be modified for local student needs as long as the content is consistent with the model course Student Learning Outcomes (SLOs)

- Additional elective courses would be required to fill out the remaining 27 to 30 units with the choice of electives focused on the needs of a student's individual career pathway.

Core and Electives for a Certificate:

Core Courses: (13-15 units total)

1. xxx101 Introduction to Geospatial Technology: (3 units)
2. xxx102 Spatial Analysis and Modeling: (3 units)
3. xxx103 Data Acquisition and Management: (3 units)
4. xxx104 Cartographic Design and Visualization: (3 units)
5. xxx110 Internship: (1-3 units)

Elective Course Options:

1. xxx120 Introduction to Remote Sensing: (3 units)
2. xxx121 Introduction to Programming for Geospatial Technologies (including web/server) : (3 units)
3. xxx122 Introduction to Field Data Collection (GPS) : (3 units)
4. xxx123 Introduction to Web Applications and Development: (3 units)
5. xxx111 Capstone - as a possible option for Internship for those unable to do an Internship: (1-2 units)

Additional Elective Course Options might include:

1. xxx100 "Geospatial Awareness Course" – this would be the General Education "spatial thinking and geospatial" course that some students may take that lead them to this career pathway and certificate: (3 units)
2. xxx130 Advanced Field Data Collection (GPS) : (3 units)
3. xxx131 Advanced Spatial Analysis and Modeling: (3 units)
4. xxx132 Introduction to Surveying: (3 units)
5. xxx133 Computer Aided Design (CAD) course: (3 units)

The Geospatial Awareness Course is a 100 level GE course that currently articulates with university programs and in some cases articulates and counts as a GE course at both the Community College and a CSU. This is the case between Shasta College and CSU, Chico and Southwestern College and San Diego State. While the Awareness level course is not part of the recommended Certificate Core, it could be counted as an elective. Including it as a possible elective means the student would: (a) not lose credits, (b) fulfill a GE area, and (c) have at least one transfer course to a university program as it does articulate with some university programs. This is also an important option as the Awareness course is a good feeder course into a geospatial program and increases diversity (Yanow, 2012).

The Additional Elective Course options listed above are currently offered at colleges with large programs or where faculty have expertise in specific topics. Section 3.3 will describe possible methods for students to take advanced or specialized courses and have them count toward their home-institution program.

Section 3.2 – Question 2: *Can the Model Certificate and Courses be used to create a transferable program under SB1440*

Colleges across the US are trying to help students build a program that includes the ability to seamlessly enter a program at a two-year college, acquire an Associate Degree and continue on to a four-year university and earn a Bachelor Degree with the least number of lost units (or courses) possible. A research brief from the American Association of Community Colleges discusses this issue in depth (Mullin, 2012). One comment from the brief should be kept in mind:

> "The nonlinear paths students take to traditional credential attainment— through activities such as swirling, free courses, massive open online courses, and prior learning credit—suggest that a traditional model of student progression may no longer be appropriate."

Swirling is defined as multiple transfers between two-year and four-year colleges. Some of the issues related to articulation and transferability of geospatial programs include:

(1) not having common course numbering systems;
(2) issues related to cross-listing courses in multiple departments;
(3) ability to easily compare content of courses;
(4) ability or difficulty in creating one-on-one articulation agreements;
(5) ability to transfer between different two-year colleges or from a two-year system to a four-year system;
(6) ability to articulate or transfer geospatial programs where the host discipline is not the same between colleges and universities; and finally
(7) the lack of four-year geospatial Bachelor Degree programs.

Many states, including California are working on processes to create common course numbering systems. This works well with long established programs such as chemistry, mathematics and geological sciences. It becomes less straight forward with emerging disciplines that do not have a well-established progression from introductory to more advanced topics. For geospatial technology, this problem is compounded because so many different disciplines host programs. Geography has been the historic host of GIS and continues to host 30 to 35% of the geospatial programs. The rest are hosted by such disciplines or departments as computer science, information technology, geology, business and environmental science. At some universities remote sensing is its own degree program. Global Positioning Systems (GPS) topics are often now included in programs teaching field data collection, including geography, geology, agriculture. In some other institutions surveying and engineering programs include basic to advanced topics in GPS.

Both panels felt that using the Model Certificate and Model Courses based on the GTCM, which includes detailed Student Learning Outcomes linked to specific skills and competencies, should provide a way to better review and compare course content between institutions. This may help

with articulation and transferability of courses between institutions if the barrier of hosting discipline differences can be overcome.

In California, SB 1440 is one attempt to provide a streamlined transfer process for students. One problem with this process for geospatial programs is the multiple host discipline issue. If a "common" core of 18 units of geospatial technology courses based on five core courses and one or more electives could be combined with other general education requirements, it could serve as one method for students to transfer their Associate Degree courses to a university.

Section 3.3 – Question 3: *How can California Community College geospatial programs meet the needs of the industry and not impact college budgets significantly, or increase faculty work load?*

One way to add program depth and not add additional courses is for students to be able to take courses at different colleges. The panels felt that there was a need to form some type of consortium that could provide both faculty and students with information about programs at other colleges and ways that students could acquire needed skills and competencies by taking courses at other institutions through a recognized process that allows them to use those credits toward completion of a Certificate or Degree at their home institution. This is in line with recommendation five from: *A Report From the 21st-Century Commission on the Future of Community Colleges – Reclaiming the American Dream: Community Colleges and the Nation's Future* (AACC) Recommendation 5 states,

> "Invest in support structures to serve multiple community colleges through collaboration among institutions and with partners in philanthropy, government, and the private sector."

And particularly the strategy for this recommendation to

> "Implement programs (in individual community colleges, systems, and states) to strengthen credentialing through rigorous assessment and transparent documentation of the knowledge and skills of students." (AACC, 2012).

While several programs already allow students to transfer some units into a program, there needs to be a streamlined process of identifying and qualifying such courses. The Model Courses and Program will provide the framework for such a process and a consortium would provide the infrastructure for students to expand their geospatial knowledge and receive credit for it. It (what is "it?) would also allow smaller colleges to reach a broader student base and benefit from the access to advanced or specialized electives from faculty and colleges that have the expertise to teach those courses.

Section 3.4 – Question 4: *How are geospatial courses and program offerings justified and sustainable under the emerging requirements for accountability both from the college point of*

view (completion rates) and student view (evidence of acquired skills)? Can that evidence be in the form of micro-credentials (badges)?

Both panels felt it was important to provide methods to document student and program successes beyond the traditional counting of awarded Certificates and Degrees. The panels also felt that badges would be useful in providing students with evidence of their abilities if the process of awarding them was rigorous and well defined.

Completion rates are one measurement of a program's success and justification by administration to continue to offer the courses. This measure of accountability has been a problem for many programs in that some students do not complete requirements for a Certificate or Degree because: (1) they transfer to another college or university; or (2) they do not need a Certificate or Degree to reach their professional career goals.

Students that do not complete a Certificate or Degree but go on to a university are seen as non-completers. These students, if not tracked, are counted as failures by the two-year college and a success by the transferred institution (Mullen, 2012). Thus, new methods of tracking students should be instituted to more accurately reflect program success. A geospatial consortium could provide the infrastructure to help colleges track student success.

Tracking and data sharing is increasing as is development of common course numbering systems and common core courses (Mullen, 2012), but student success measures should also include students who may already have degrees, but need to update their technology skills. This updating of technical skills and lifelong learning is part of the mission of community colleges, but it is not easy to track these students and count them as success rather than non-completers.

Other methods that may help identify student and program success are through a program of earning Badges for specific skills and competencies. As mentioned above students are seen as "drop outs" if they take only a few courses in a program and do not earn a Certificate or Degree. Yet, many students, especially those returning students or lifelong learners do not need to earn another Certificate or Degree. They just need to update or acquire skills and competencies to meet specific workforce needs and be able to document that attainment in a recognized process. Most panel participants felt that a program where students can earn Badges could provide colleges, students and industry with the needed evidence of professional attainment and program success.

It was stressed by panel members however that badges would not be useful if they do not reflect mastery of a specific skill and earning them must be rigorous. They must: (a) include an exam based on specific skills and competencies; and (b) be recognized by geospatial professional organizations such as the GISCI, URISA, and others.

As a second component to this question, if Badges are created what competencies should be addressed first? The panels recommended (based on SLOs and competency clusters) the initial Badge topics could include:

1) Editing: Basic and Advanced
2) Metadata
3) GPS
4) Map Design
5) Topology
6) Databases: Creation; Management
7) Earth Geometry: Projections, Datum, Coordinate Systems
8) Spatial Analysis: Basic (Overlays, buffers, etc.); Modeling; GeoStatistics; raster analysis; georeferencing
9) Remote Sensing: Classification, Image Enhancement; Band Composites; Feature Extraction
10) Ethics/Professionalism

Discussions included ways to organize the competencies to better identify topic areas for badges. One method of structuring the competencies was by grouping them into 12 Competency Clusters and creating a geospatial knowledge map modeled on an example (figure 3) from the Khan Academy (Khan, 2012) for Mathematics.

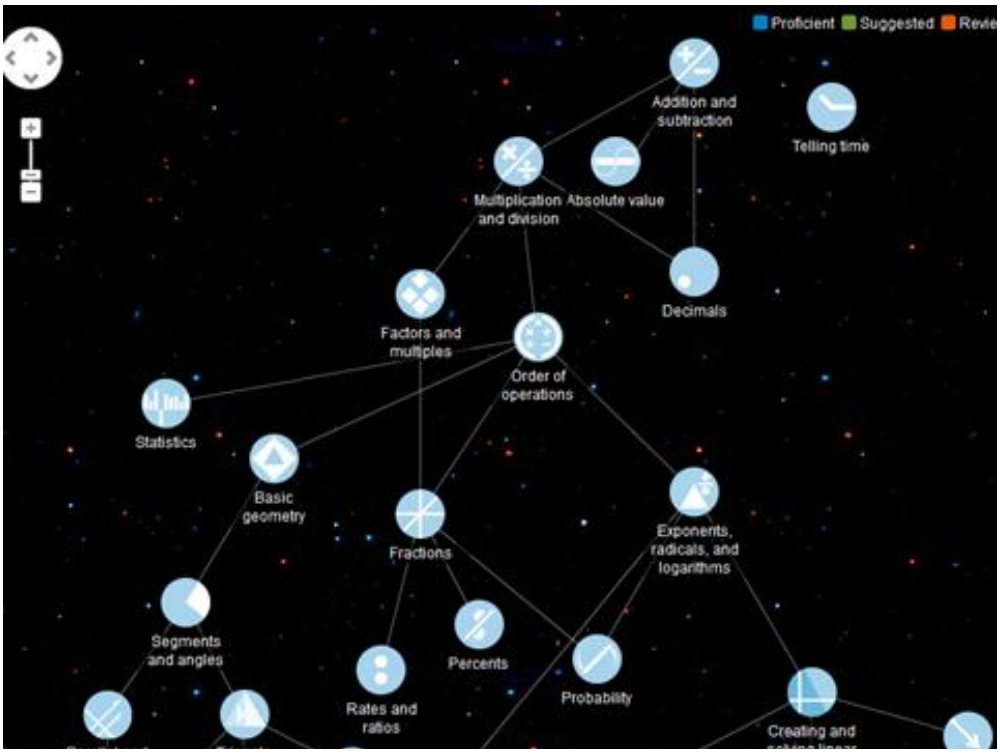

Figure 3: Mathematics Knowledge Map

Competencies are organized in a Knowledge Map to link competencies and to allow users to move through the map as they build their skills.

For geospatial technology, the Team organized the 12 Competency Clusters into a Geospatial Knowledge Map (Figure 4). As you zoom into the Map, additional competencies and links appear (figure 5). The fully developed Geospatial Knowledge Map should be interactive and link to resources to learn the competencies and ways to earn the badges.

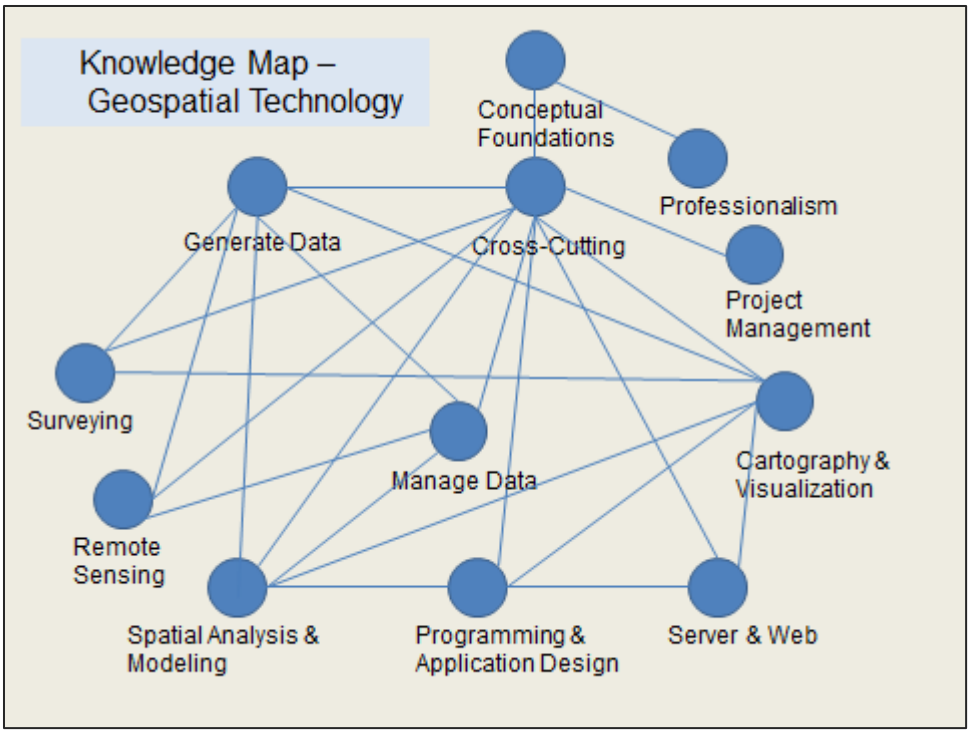

Figure 4: Geospatial Knowledge Map Grouped in 12 Clusters Draft

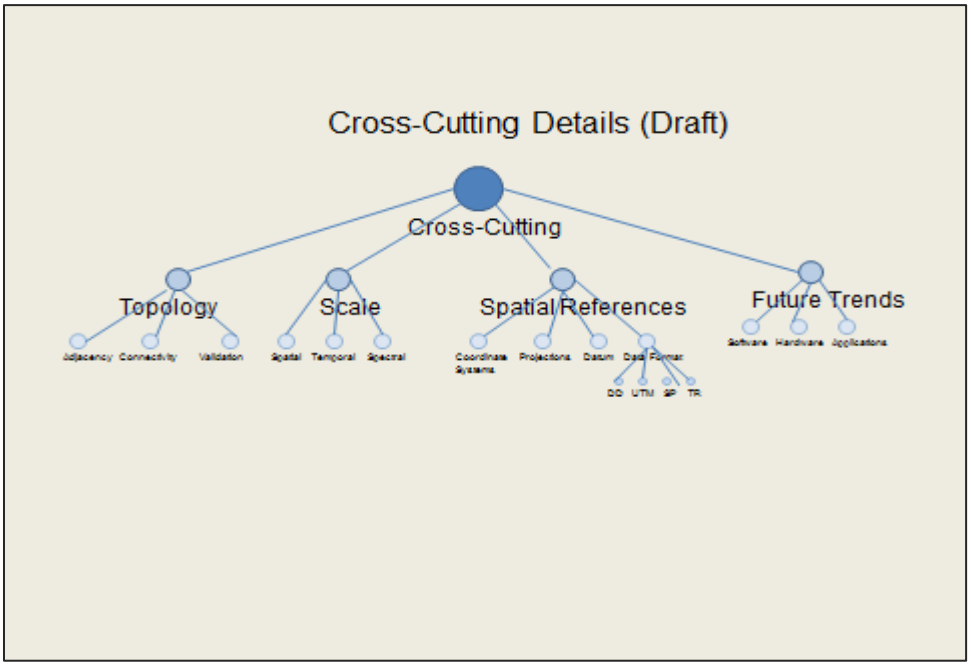

Figure 5: Cross-Cutting Cluster Details Draft

Section 4 – Recommendations and Next Steps:

This project was tasked with researching ways that California Community Colleges can help prepare students entering or updating their skills to meet the needs of the geospatial industry and investigate whether awarding badges based on industry validated skills and competencies would be of benefit to students, colleges and industry. The following Recommendations and Next Steps are outcomes from research carried out as part of this project.

Specific Recommendations and Next Steps

1: *Recognize and pilot test the use of the Model Certificate and Model Course structure (see section 3.1 for details) defined by the panels as guidelines for all California Community College Geospatial Programs and specifically:*

a) Adopt the Model Courses and Certificate Guidelines for Core and Electives
b) Mentor colleges wishing to pilot test the use of the Models at five colleges

2: *Investigate creating a Geospatial Technology transfer program (SB 1440) based on the Model Courses and Certificate*

a) Work with educators and administration at community colleges and Universities to create a common numbering system for geospatial technology
b) Work with educators and administration to overcome barriers for cross-listing courses
c) Review existing and proposed transfer programs and determine the feasibility of creating an 18 unit core of geospatial technology model courses
d) Propose a Model Transfer Program for a Geospatial Science and Technology Associate Degree

3: *Create a Consortium to provide infrastructure to support course sharing, student tracking and documentation of program and student success and provide professional development for faculty wishing to update their skills and competencies in emerging technology*.

a) Provide process and infrastructure so that students can find and take elective courses not offered by their home institution and get credit for those courses toward their certificate or degree program;
b) Provide process and infrastructure so that colleges can post course offerings, both on campus and online, that can be located and be taken by students from other institutions
c) Provide a clearinghouse to host student portfolios in order to maintain contact with students and track their long-term success.
d) Increase and share faculty expertise in emerging geospatial technology through targeted professional development;

4: *Develop a pilot project to create badges through collaboration with Purdue University and the Mozilla Foundation starting with those suggested by the panels and investigate other options for hosting and awarding badges*

a) Work with Purdue University "badge-powered learning" system, Passport Studio beta site to create badges
b) Pilot test methodology to award Badges including development of study resources, exam questions and portfolio guidelines
c) If Pilot test successful, develop full program of offering and awarding Badges
d) Research how best to work with industry and professional organizations to recognize and promote Badges.
e) Develop formal agreements with industry partners and professional organizations who have expressed interest in Badges such as Esri, GISCI, USGIF, CGIA
f) Examine knowledge areas, and other related needs to finalize the Geospatial Technology Knowledge Map and link to competencies identified by the GTCM and MetaDACUM. DACUM, which stands for "Developing a Curriculum", is a professionally facilitated activity where "expert workers" from an occupation are brought together for two intense days in order to define what they do as part of their occupation. The geospatial MetaDACUM was compiled by the GeoTech Center. John Johnson, GeoTech's DACUM Facilitator, carried out several DACUMs for GIS Technician or Technologist and remote sensing level occupations across the US. The outcome from each event is a two sided graphic listing the Tasks and Duties as well as the knowledge and abilities need for that occupation. Many industries and educational institutions use this process to help build training and education programs. One weakness of a DACUM is that it may represent only the "local or regional" workforce at one point in time. In order to overcome some of that limitation, Mr. Johnson has developed a process to incorporate outcomes from Multiple DACUMs held around the US at different times and cluster them into like categories that were then put into one MetaDACUM. The MetaDACUM was then vetted with more than 400 industry experts in order to define those most common or important for entry level geospatial occupations.
g) Work with Khan Academy to see if Geospatial Technology can be added to other knowledge areas

Conclusion

The Model Certificate and Courses developed by the GeoTech Center and validated by industry are being used by colleges and universities across the country for program development and evaluation. For the first time, educators have defined a specific set of core courses and electives as an outcome of the California Community College Geospatial Project. This outcome and other recommendations of this project will help efforts to articulate and transfer courses and track student progress and program success.

Badges aligned with specific workforce competencies integrated in the model courses curriculum and earned using a rigorous process is another way for students, employers and geospatial programs to document and measure success. Will badges be a long term solution or a "flash in the pan"? The Team can't answer this question with certainty, but with millions of dollars in funding going into investigating this, it is important that community colleges to investigate their potential and incorporate them into their long term program planning.

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Appendix A

and

Appendix B

C3GIS Industry Survey - Model Certificate, Courses, Micro-Credentials

1. Optional - Please answer the following:

		Response Percent	Response Count
Name:		**100.0%**	**10**
Company:		**100.0%**	**10**
Address:		**100.0%**	**10**
Address 2:		30.0%	3
City/Town:		**100.0%**	**10**
State:		**100.0%**	**10**
ZIP:		**100.0%**	**10**
Country:		90.0%	9
Email Address:		**100.0%**	**10**
Phone Number:		**100.0%**	**10**
		answered question	**10**
		skipped question	**1**

2. Type of Industry

		Response Percent	Response Count
Local Government		**60.0%**	**6**
State Government		0.0%	0
Federal Government		10.0%	1
Educational Institution		10.0%	1
Private Industry		20.0%	2
Consultant		0.0%	0
		Other (please specify)	2
		answered question	**10**
		skipped question	**1**

3. On average how much of your day do you spend working with Geospatial technologies (management or technical)?

		Response Percent	Response Count
0		0.0%	0
less than 1 hour		0.0%	0
1-2 hours		0.0%	0
over 2 but less than 4 hours		27.3%	3
more than 4 but less than 6 hours		18.2%	2
over 6 hours		**54.5%**	**6**
		answered question	**11**
		skipped question	**0**

4. How did you acquire your geospatial technology skills (check all that apply)?

	Response Percent	Response Count
Learned on the job	**90.9%**	**10**
No formal training in Geospatial, but have certificate, or degree in another field	27.3%	3
Vendor Courses or Training	72.7%	8
Geospatial Courses but less than a certificate	27.3%	3
Certificate in GIS, or Geospatial	54.5%	6
Associate degree in GIS, or Geospatial	18.2%	2
Batchelor degree that included courses in Geospatial	18.2%	2
Masters degree focused on Geospatial	9.1%	1
PhD degree focused on Geospatial	0.0%	0
	Other (please specify)	3
	answered question	**11**
	skipped question	**0**

5. If you were going to design a model curriculum with 3 to 5 CORE courses, what would they be? Use the options listed below, or add your own:

	Response Percent	Response Count
Introduction to Geospatial Technologies (GIS, Remote Sensing, GPS, mobile technologies)	81.8%	9
Spatial Analysis	90.9%	10
Data Acquisition & Management	**100.0%**	**11**
Cartographic Design & Visualization	90.9%	10
Introduction to Remote Sensing	0.0%	0
Programming	18.2%	2
Web Application Development	18.2%	2
Field Data Collection	27.3%	3
Internship	45.5%	5
Capstone Project	9.1%	1
Other (please specify)	27.3%	3
	answered question	**11**
	skipped question	**0**

6. If you were going to design a model curriculum what ELECTIVE courses, what would they be? Select as many of the options below as you think should be included:

	Response Percent	Response Count
Introduction to Geospatial Technologies (GIS, Remote Sensing, GPS, mobile technologies)	36.4%	4
Spatial Analysis	36.4%	4
Data Acquisition & Management	18.2%	2
Cartographic Design & Visualization	27.3%	3
Introduction to Remote Sensing	72.7%	8
Programming	54.5%	6
Web Application Development	63.6%	7
Field Data Collection	**90.9%**	**10**
Internship	27.3%	3
Capstone Project	45.5%	5
Please add other suggestions or comments here:	27.3%	3
	answered question	**11**
	skipped question	**0**

7. How important do you think it is that a certificate earned be listed on a college transcript?

	Response Percent	Response Count
Essential	27.3%	3
Very important	**45.5%**	**5**
Important	9.1%	1
Neutral	9.1%	1
Not Very Important	9.1%	1
Not important at all	0.0%	0
	Other (please specify)	2
	answered question	**11**
	skipped question	**0**

8. If Geospatial Micro-Credentials (or Badges) were available at your community college, how likely would you be to enroll in a course in which they could be earned?

	Response Percent	Response Count
Extremely likely	0.0%	0
Very likely	**45.5%**	**5**
Moderately likely	27.3%	3
Slightly likely	0.0%	0
Not at all likely	27.3%	3
	answered question	**11**
	skipped question	**0**

9. If Geospatial Micro-Credentials (or Badges) were available at your community college, how likely would you be to recommend that your co-workers or employees enroll in a course in which they could be earned?

	Response Percent	Response Count
Extremely likely	18.2%	2
Very likely	27.3%	3
Moderately likely	**36.4%**	**4**
Slightly likely	0.0%	0
Not at all likely	18.2%	2
Other (please specify)		2
answered question		**11**
skipped question		**0**

10. Would you be more likely to take geospatial courses at your local community college, or recommend them to others in your organization if they are offered (choose all that apply):

	Response Percent	Response Count
On campus	45.5%	5
Online	36.4%	4
Hybrid (campus & online)	**63.6%**	**7**
No preference	18.2%	2
Would not take a course	0.0%	0
Other (please specify)		2
answered question		**11**
skipped question		**0**

11. Overall, are you satisfied with your local or online geospatial education curriculum?

		Response Percent	Response Count
Extremely satisfied		18.2%	2
Moderately satisfied		**45.5%**	**5**
Slightly satisfied		18.2%	2
Neither satisfied nor dissatisfied		0.0%	0
Slightly dissatisfied		9.1%	1
Moderately dissatisfied		0.0%	0
Extremely dissatisfied		0.0%	0
No Opinion		9.1%	1
		Other (please specify)	2
		answered question	**11**
		skipped question	**0**

12. Would you, as an employer, see value in an applicant having earned one or more micro-credentials (or Badges)?

		Response Percent	Response Count
Very Valuable		0.0%	0
Valuable		36.4%	4
Somewhat Valuable		**45.5%**	**5**
Little Value		9.1%	1
No Value		9.1%	1
		Other (please specify)	3
		answered question	**11**
		skipped question	**0**

13. If Micro-Credentials or Badges were created, which of the following competency clusters do you think would be most useful for entry level workers. Please use comment section to add ideas or additional information.

	Very Important	Important	Somewhat Important	Not Important	Response Count
1) Cross Cutting: includes Earth geometry, scale, coordinate systems, projections	**45.5% (5)**	36.4% (4)	0.0% (0)	18.2% (2)	11
2) Conceptual Foundations: including the history, future trends, applications and uses (other than those scientific principles listed under Cross Cutting)	10.0% (1)	**60.0% (6)**	0.0% (0)	30.0% (3)	10
3) Cartography and Visualization: includes generating, evaluating and presenting products in different formats	**60.0% (6)**	30.0% (3)	0.0% (0)	10.0% (1)	10
4) Generate Data: includes acquire and create and field data collection, GPS	36.4% (4)	**45.5% (5)**	9.1% (1)	9.1% (1)	11
5) Manage Data: includes metadata, database design, schema development, database maintenance	36.4% (4)	**54.5% (6)**	0.0% (0)	9.1% (1)	11
6) Programming and Application Design: includes modify or create scripts, automate processes, customize applications or create new applications	18.2% (2)	**63.6% (7)**	0.0% (0)	18.2% (2)	11
7) Project Management: includes all skills and competencies associated with planning, implementation and oversight of projects including defining hardware and software requirements, legal and business issues related to project management	**36.4% (4)**	**36.4% (4)**	9.1% (1)	18.2% (2)	11
8) Professionalism: including ethics, participation in professional organizations and certification	18.2% (2)	**54.5% (6)**	18.2% (2)	9.1% (1)	11

9) Remote Sensing: includes scientific concepts important for RS, data acquisition and generation, as well as management of imagery data	0.0% (0)	**36.4% (4)**	**36.4% (4)**	27.3% (3)	11
10) Spatial Analysis and Modeling: includes basic to advanced analysis and optimizing analysis through models	27.3% (3)	**45.5% (5)**	18.2% (2)	9.1% (1)	11
11) Surveying: Includes field data collection using survey grade instruments and creating legal property boundary descriptions.	0.0% (0)	**45.5% (5)**	36.4% (4)	18.2% (2)	11
12) Server and the Web: includes setting up and developing a web application and Server, creating/maintaining web to display products and Cloud computing	27.3% (3)	**45.5% (5)**	9.1% (1)	18.2% (2)	11
				Please Comment	3
				answered question	**11**
				skipped question	**0**

14. Respond to this question with the degree to which you agree or disagree with the following statement: "Staffing at my organization or agency is adequate to meet our current geospatial needs":

		Response Percent	Response Count
Strongly agree		9.1%	1
Agree		36.4%	4
Neutral		0.0%	0
Disagree		**45.5%**	**5**
Strongly disagree		9.1%	1
Not applicable		0.0%	0
		Comment	4
		answered question	**11**
		skipped question	**0**

15. Does your organization recommend or give added weight, or recognition to employees or potential employees that have geospatial certifications, from a professional organization such as ASPRS or GISCI?

	Response Percent	Response Count
Yes, but no salary increase upon earning earning certification	18.2%	2
Yes, but no salary increase when hiring	18.2%	2
Yes, new hires with certification earn more	9.1%	1
Yes, employees earning certification get a raise	0.0%	0
No recognition or increase	**54.5%**	**6**
Don't know	0.0%	0
	Other (please specify)	2
	answered question	**11**
	skipped question	**0**

16. Is there anything else that you would like to share with our group?

	Response Count
	2
answered question	**2**
skipped question	**9**

Page 2, Q4. How did you acquire your geospatial technology skills (check all that apply)?		
1	Attended Community College courses in GIS, kept in contact with professors to network, learn, discuss and explore solutions.	Nov 14, 2012 6:03 AM
2	BA in Geography with emphasis in GIS	Oct 3, 2012 9:03 AM
3	I learned from scratch on Arc/Info command line UNIX	Sep 19, 2012 2:31 PM

Page 3, Q5. If you were going to design a model curriculum with 3 to 5 CORE courses, what would they be? Use the options listed below, or add your own:		
1	If it were a 5 core course, a choice between Web Application Development or Field Data Collection.	Nov 14, 2012 6:27 AM
2	I believe an advanced data acquisition and management class would be very valuable. Most of our hires don't understand how to BUILD GIS datasets - we see a lot of errors in duplicate entries, lack of topology, etc. They haven't used the data and thought about it from a perspective other than their project.	Sep 19, 2012 2:58 PM
3	1. Basic geography applied to geotechnologies	Sep 18, 2012 4:12 PM

Page 3, Q6. If you were going to design a model curriculum what ELECTIVE courses, what would they be? Select as many of the options below as you think should be included:		
1	GIS applications in Industry ... i.e., transportation, retail, government, health, etc.	Nov 14, 2012 6:27 AM
2	spatial statistics - or a more advanced spatial analysis course - I find that the intro to spatial analysis course is often too simplistic. It would also be helpful to cover geostatistical analysis. It would be easy to see an entire course on Kriging or Interpolation techniques. Another useful course might be related to complementary software. For example, if the program is Esri-centric (which is fine by me), then an introduction to other tools like SatScan, GeoDa, CrimeStat, Google product, etc. would be good.	Oct 3, 2012 12:26 PM
3	NOte - I believe that programming comes later.	Sep 19, 2012 2:58 PM

Page 3, Q7. How important do you think it is that a certificate earned be listed on a college transcript?		
1	Gets your foot in the door that can be proven with job performance.	Nov 14, 2012 6:27 AM
2	Its such a simple thing to do and the students could benefit greatly from it (if not in the job market, then just emotionally).	Oct 3, 2012 12:26 PM

Page 3, Q9. If Geospatial Micro-Credentials (or Badges) were available at your community college, how likely would you be to recommend that your co-workers or employees enroll in a course in which they could be earned?

1	I don't find the concept of a badge really that useful - it only would describe a course taken, rather than mastery of a subject.	Sep 19, 2012 2:58 PM
2	*Only an intro to gis or one of the HAZUS modules (see FEMA)	Sep 18, 2012 4:12 PM

Page 3, Q10. Would you be more likely to take geospatial courses at your local community college, or recommend them to others in your organization if they are offered (choose all that apply):

1	I wish to stress the importance of on campus education. While today's work environment allows alternative work environments (i.e. telecommute, working online, etc.) there is value in on campus "show up in person" participation and working in a team setting.	Nov 14, 2012 6:27 AM
2	I received much of my GIS education at the local community college level. I found the semester system to be superior to our own UCD quarter system for learning a software package.	Oct 3, 2012 12:26 PM

Page 3, Q11. Overall, are you satisfied with your local or online geospatial education curriculum?

1	There is never enough instruction in spatial statistics, python or R programming as it relates to geospatial education, or web mapping. I'd like more of those.	Oct 3, 2012 12:26 PM
2	We have a lot of local resources, from COmmunity COlleges to Masters Programs.	Sep 19, 2012 2:58 PM

Page 3, Q12. Would you, as an employer, see value in an applicant having earned one or more micro-credentials (or Badges)?

1	Must be proven with work performance but a valuable starting point.	Nov 14, 2012 6:27 AM
2	It will take some time to determine how valuable it is. I would be more likely to hire someone with a spatial analysis or spatial statistics badge over others. However, as with GIS certificate programs, I imagine there will be wide variation in the level of expertise of the 'graduates.'	Oct 3, 2012 12:26 PM
3	*Need full certificate	Sep 18, 2012 4:12 PM

Page 3, Q13. If Micro-Credentials or Badges were created, which of the following competency clusters do you think would be most useful for entry level workers. Please use comment section to add ideas or additional information.

1	The above answers are based on my county government's requirements. Currently we have no remote sensing activity in the county.	Nov 16, 2012 10:59 AM
2	Micro-credentials perhaps would be of more use for the student than for the employer. This would be in the sense that it would assist the student in planning a sequence of courses that meet their needs or expectations. At the employer level, candidates are often evaluated for skill sets that may not match the sequence identified for a micro-credential. This evaluation often looks for other characteristics of the candidate including the ability to work with others on common projects, effective skills in writing and presentation. Many organizations have very specific applications or suites of software where the position will be focused on the implementation of that software with others. The general expectation is that a candidate will not have the full skill set, but will develop the needed skill set on the job and with additional training.	Sep 19, 2012 6:54 AM
3	Those items judged "Not important" are primarily skills I would not expect for an entry-level position.	Sep 18, 2012 3:44 PM

Page 3, Q14. Respond to this question with the degree to which you agree or disagree with the following statement: "Staffing at my organization or agency is adequate to meet our current geospatial needs":

1	we have 7 people in our GIS group - none of us have enough programming expertise to create map web applications or modify current viewers. There is a lot of pressure to get up to speed in this area - most of our staff is dedicated to projects (mainframe, hardware/software/libraries, parcel layer, mapping, and various smaller projects as they arise (zoning is now a priority). We could use a web centric person, or training in that area. Also our youngest is 51 so we are likely to lose people to retirement in the next 5 years.	Nov 16, 2012 10:59 AM
2	We are currently significantly understaffed. Due to the current fiscal crisis, our agency has frozen new hiring.	Nov 14, 2012 6:27 AM
3	We have adequate staffing and many staff in other areas have developed skills with GIS. It would be nice to grow the GIS as a department and add additional staffing.	Oct 3, 2012 8:01 AM
4	The employment sector in the geospatial industry is particularly dynamic. There is a tremendous need for new entries into most industry sectors for geospatial.	Sep 19, 2012 6:54 AM

Page 3, Q15. Does your organization recommend or give added weight, or recognition to employees or potential employees that have geospatial certifications, from a professional organization such as ASPRS or GISCI?		
1	We look at a certification as "added" value to applicants qualifications. It is currently not a "requirement" for some specific job positions such as Crime and Intelligence Analysts at our agency.	Nov 14, 2012 6:27 AM
2	Our merit and promotions process might consider such certifications, but other criteria are FAR more important.	Oct 3, 2012 12:26 PM

Page 3, Q16. Is there anything else that you would like to share with our group?		
1	I find that there is a unique group of community college students that are so intrinsically motivated and driven, given the opportunities of education and training and the right career paths will be on their way to very bright and successful futures.	Nov 14, 2012 6:27 AM
2	The County of Los Angeles has recently released a set of GIS classification (see http://egis3.lacounty.gov/eGIS/2012/08/02/los-angeles-county-releases-gis-classifications-and-specifications-job-descriptions/) This is the result of three years of effort and the collaboration of over 8 of our departments to create a set of classes that will support the use of geospatial technologies in the County. I hope that these classifications will help support the work of educational insitutions to prepare our future staff. One comment on the courses - I don't see much mention of the concept of topology. This is a critical part of any GIS data development, and is something that we see as a major issue with freshly minted GIS staff - they don't understand the impacts of overlapping polygons, dangles, etc. Note that all of these were part of the data model by default back in the ARc/Info coverage days, but even though ESRI has gone away from this, it is still the foundation of most GIS data today. For example, city boundaries cannot overlap, they cannot have gaps, and they must be distinct. Only topology can resolve this - otherwise data anlalysis will always fall short.	Sep 19, 2012 2:58 PM

C3GIS Educator Survey - Model Certificate, Courses, Micro-Credentials

1. Optional - Please answer the following:

	Response Percent	Response Count
Name:	**100.0%**	**9**
College:	**100.0%**	**9**
Address:	88.9%	8
Address 2:	11.1%	1
City/Town:	**100.0%**	**9**
State:	**100.0%**	**9**
ZIP:	**100.0%**	**9**
Country:	77.8%	7
Email Address:	**100.0%**	**9**
Phone Number:	88.9%	8
	answered question	**9**
	skipped question	**3**

2. Department Hosting Geospatial Program or courses. Check choose all that apply.

	Response Percent	Response Count
Computer Science	0.0%	0
Environmental Science	0.0%	0
Geography	**88.9%**	**8**
Geology	0.0%	0
Geospatial (GIS)	11.1%	1
Social Science	0.0%	0
Earth Sciences	11.1%	1
	Other (please specify)	4
	answered question	**9**
	skipped question	**3**

3. Please tell us about your college geospatial program. Check all that apply.

	Response Percent	Response Count
No current program offered	0.0%	0
Courses only	8.3%	1
Certificate with less than 18 units	**50.0%**	**6**
Certifcate with more than 18 units - not state approved	16.7%	2
Certificate with more than 18 units - state approved	**50.0%**	**6**
Associate Degree	16.7%	2
Please comment on your answers to carify the types of programs offered by your college		4
	answered question	**12**
	skipped question	**0**

4. How many geospatial courses do you teach (on average) each semester?

	Response Percent	Response Count
0	0.0%	0
less than 1	16.7%	2
1-2	25.0%	3
over 2 but less than 4	**58.3%**	**7**
more than 4 but less than 6	0.0%	0
more than 6	0.0%	0
	Other (please specify)	1
	answered question	**12**
	skipped question	**0**

5. How did you acquire your geospatial technology skills (check all that apply)?

	Response Percent	Response Count
Learned on the job	58.3%	7
No formal training in Geospatial, but have certificate, or degree in another field	8.3%	1
Vendor Courses or Training	25.0%	3
Geospatial Courses but less than a certificate	33.3%	4
Certificate in GIS, or Geospatial	8.3%	1
Associate degree in GIS, or Geospatial	0.0%	0
Batchelor degree that included courses in Geospatial	25.0%	3
Masters degree focused on Geospatial	**66.7%**	**8**
PhD degree focused on Geospatial	8.3%	1
	Other (please specify)	4
	answered question	**12**
	skipped question	**0**

6. If you were going to design a model curriculum with 3 to 5 CORE courses, what would they be? Use the options listed below, or add your own:

	Response Percent	Response Count
Introduction to Geospatial Technologies (GIS, Remote Sensing, GPS, mobile technologies)	90.9%	10
Spatial Analysis	90.9%	10
Data Acquisition & Management	81.8%	9
Cartographic Design & Visualization	**100.0%**	**11**
Introduction to Remote Sensing	36.4%	4
Programming	9.1%	1
Web Application Development	18.2%	2
Field Data Collection	36.4%	4
Internship	72.7%	8
Capstone Project	18.2%	2
Other (please specify)	9.1%	1
answered question		**11**
skipped question		**1**

7. If you were going to design a model curriculum what ELECTIVE courses, what would they be? Select as many of the options below as you think should be included:

	Response Percent	Response Count
Introduction to Geospatial Technologies (GIS, Remote Sensing, GPS, mobile technologies)	9.1%	1
Spatial Analysis	9.1%	1
Data Acquisition & Management	18.2%	2
Cartographic Design & Visualization	9.1%	1
Introduction to Remote Sensing	54.5%	6
Programming	54.5%	6
Web Application Development	**72.7%**	**8**
Field Data Collection	45.5%	5
Internship	27.3%	3
Capstone Project	45.5%	5
Please add other suggestions or comments here:	9.1%	1
	answered question	**11**
	skipped question	**1**

8. How important do you think it is that a certificate earned be listed on a college transcript?

		Response Percent	Response Count
Essential		**45.5%**	**5**
Very important		36.4%	4
Important		9.1%	1
Neutral		9.1%	1
Not Very Important		0.0%	0
Not important at all		0.0%	0
		Other (please specify)	0
		answered question	**11**
		skipped question	**1**

9. Do you think Geospatial Micro-Credentials (or Badges) are a good idea?

		Response Percent	Response Count
Extremely useful		**36.4%**	**4**
Very useful		**36.4%**	**4**
Moderately useful		27.3%	3
Slightly useful		0.0%	0
Not at all useful		0.0%	0
		Other (please specify)	0
		answered question	**11**
		skipped question	**1**

10. If Geospatial Micro-Credentials (or Badges) were available at your community college, who do you think would benefit. Check all that apply and comment as needed for clarification

	Response Percent	Response Count
College recognition of program success	81.8%	9
Students recognition of abilities	**100.0%**	**11**
Employers recognition of employee abilities	90.9%	10
No benefit to college	0.0%	0
No benefit to students	0.0%	0
No benefit for employers	0.0%	0
	Please add your opinions on the	1
	answered question	**11**
	skipped question	**1**

11. How are the courses in your geospatial program offered:

	Response Percent	Response Count
All courses are offered only on campus	**72.7%**	**8**
All courses are offered only Online	0.0%	0
Some courses are offered as Hybrid (campus & online)	27.3%	3
Some courses are on campus	18.2%	2
Some courses are Online	18.2%	2
Don't know the format of all courses	0.0%	0
No courses are currently offered	0.0%	0
	Other (please specify)	0
	answered question	**11**
	skipped question	**1**

12. Would you, as an educator, see value in offering one or more micro-credentials (or Badges)?

		Response Percent	Response Count
Very Valuable		**54.5%**	**6**
Valuable		18.2%	2
Somewhat Valuable		27.3%	3
Little Value		0.0%	0
No Value		0.0%	0
		Other (please specify)	0
		answered question	**11**
		skipped question	**1**

13. If Micro-Credentials or Badges were created, which of the following competency clusters do you think would be most useful for entry level workers. Please use comment section to add ideas or additional information.

	Very Important	Important	Somewhat Important	Not Important	Response Count
1) Cross Cutting: includes Earth geometry, scale, coordinate systems, projections	**45.5% (5)**	27.3% (3)	27.3% (3)	0.0% (0)	11
2) Conceptual Foundations: including the history, future trends, applications and uses (other than those scientific principles listed under Cross Cutting)	18.2% (2)	**45.5% (5)**	27.3% (3)	9.1% (1)	11
3) Cartography and Visualization: includes generating, evaluating and presenting products in different formats	**60.0% (6)**	40.0% (4)	0.0% (0)	0.0% (0)	10
4) Generate Data: includes acquire and create and field data collection, GPS	**63.6% (7)**	36.4% (4)	0.0% (0)	0.0% (0)	11
5) Manage Data: includes metadata, database design, schema development, database maintenance	**54.5% (6)**	45.5% (5)	0.0% (0)	0.0% (0)	11
6) Programming and Application Design: includes modify or create scripts, automate processes, customize applications or create new applications	10.0% (1)	**50.0% (5)**	30.0% (3)	10.0% (1)	10
7) Project Management: includes all skills and competencies associated with planning, implementation and oversight of projects including defining hardware and software requirements, legal and business issues related to project management	**36.4% (4)**	27.3% (3)	**36.4% (4)**	0.0% (0)	11
8) Professionalism: including ethics, participation in professional organizations and certification	18.2% (2)	**54.5% (6)**	27.3% (3)	0.0% (0)	11

9) Remote Sensing: includes scientific concepts important for RS, data acquisition and generation, as well as management of imagery data	9.1% (1)	**45.5% (5)**	**45.5% (5)**	0.0% (0)	11
10) Spatial Analysis and Modeling: includes basic to advanced analysis and optimizing analysis through models	**36.4% (4)**	**36.4% (4)**	27.3% (3)	0.0% (0)	11
11) Surveying: Includes field data collection using survey grade instruments and creating legal property boundary descriptions.	10.0% (1)	**50.0% (5)**	30.0% (3)	10.0% (1)	10
12) Server and the Web: includes setting up and developing a web application and Server, creating/maintaining web to display products and Cloud computing	10.0% (1)	40.0% (4)	**50.0% (5)**	0.0% (0)	10
				Please Comment	2

answered question	**11**
skipped question	**1**

14. What are the top two (2) concerns you have about your geospatial program. Add more if you feel there are other important issues

	Response Count
	8

answered question	**8**
skipped question	**4**

15. Do you think that geospatial programs should be accredited? (If Yes or No, also please comment, below)

	Response Percent	Response Count
Yes	**54.5%**	**6**
No	0.0%	0
Not sure	45.5%	5
No opinion	0.0%	0
If Yes or No, please comment		3
answered question		**11**
skipped question		**1**

16. Is there anything else that you would like to share with our group?

	Response Count
	2
answered question	**2**
skipped question	**10**

Page 2, Q1. Optional - Please answer the following:

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Page 2, Q2. Department Hosting Geospatial Program or courses. Check choose all that apply.

1	Division: Career Tech Education	Oct 12, 2012 12:47 AM
2	Physical Sciece Dept - Geography (sub-department)	Oct 3, 2012 5:40 PM
3	Marine Science and Technology	Sep 28, 2012 3:07 PM
4	Park Management	Sep 22, 2012 8:45 AM

Page 2, Q3. Please tell us about your college geospatial program. Check all that apply.

1	resubmitting GIS certificate for 20 units and updating material	Oct 12, 2012 12:47 AM
2	State Approved	Oct 10, 2012 2:40 PM
3	Certificate of Accomplishment - 15 units Certificate of Achievement - 31 units (state-approved) AS in GIS-GPS	Oct 3, 2012 5:40 PM
4	Skills Certificate < 18 units	Oct 3, 2012 7:56 AM

Page 2, Q4. How many geospatial courses do you teach (on average) each semester?

1	Introduction to GIS, (Fall and Spring) Advanced GIS (once a year usually in Spring)	Oct 3, 2012 5:40 PM

Page 2, Q5. How did you acquire your geospatial technology skills (check all that apply)?		
1	landscape architecture	Oct 12, 2012 12:47 AM
2	I was in school before degrees in geospatial were offered	Oct 3, 2012 7:44 AM
3	Learn a lot by teaching, especially through student projects.	Sep 28, 2012 3:07 PM
4	Conferences and Seminars	Sep 22, 2012 8:45 AM

Page 3, Q6. If you were going to design a model curriculum with 3 to 5 CORE courses, what would they be? Use the options listed below, or add your own:		
1	Either Capstone project or Internship.	Sep 28, 2012 3:31 PM

Page 3, Q7. If you were going to design a model curriculum what ELECTIVE courses, what would they be? Select as many of the options below as you think should be included:		
1	include CAD requirement	Oct 12, 2012 12:53 AM

Page 3, Q10. If Geospatial Micro-Credentials (or Badges) were available at your community college, who do you think would benefit. Check all that apply and comment as needed for clarification		
1	My response above is based on the assumption that micro-credentials will be reflected on student transcript and will be approved by the college and state as a valid measurement of program success.	Oct 3, 2012 6:31 PM

Page 3, Q13. If Micro-Credentials or Badges were created, which of the following competency clusters do you think would be most useful for entry level workers. Please use comment section to add ideas or additional information.		
1	The micro-credentials will be driven by the most current needs of the employers in the geospatial field. We should be prepared to tailor our courses to meet the need, which may change overtime and also by geographic region.	Oct 3, 2012 6:31 PM
2	Something for possible discussion at the workshop -- some of these are technical competencies which could be demonstrated and some are more conceptual like professionalism and future trends. I think it might be worth exploring the badge model which puts some conceptual ideas and ethics into each and every badge (analogous to Boy Scouts, each badge includes	Sep 28, 2012 3:31 PM

Page 3, Q13. If Micro-Credentials or Badges were created, which of the following competency clusters do you think would be most useful for entry level workers. Please use comment section to add ideas or additional information.

	something about safety, and something about professions in that field).

Page 3, Q14. What are the top two (2) concerns you have about your geospatial program. Add more if you feel there are other important issues

1	enrollment and certificate must be provided to enable courses to be offered	Oct 12, 2012 12:53 AM
2	1. Recruitment 2. Job placement	Oct 5, 2012 2:41 PM
3	-Low enrollment -Lack of sufficient internships or local job opportunities for students -Unclear as to where to put GIS in the college (Geography? Computer Science? Vocational?)	Oct 4, 2012 11:12 PM
4	1. To keep the course offerings as scheduled and prevent classes from budget cuts. 2. How to account for students who benfited from 1-2 courses (got a job or moved-up in current job) but did not complete the program. These are treated as 'drop-outs'. 3. Maintain the enrollment to a higher fill-rate when compared to other large-size. GE. and transfer courses. 3. Limited fiscal resources is a challenge for maintaining the hardware and software license.	Oct 3, 2012 6:31 PM
5	1) Funding/budget. 2) Enrollment	Oct 3, 2012 8:02 AM
6	(1)We compete for state funding with accredited programs. Because there is no accreditation in our field, we loose funds to accredited programs (2)The state only recognizes certificates that are for lots of units (6+ classes). Many students want only 1 or 2 classes to gain the skills that they need, so we do not get any 'credit' for those students.	Oct 3, 2012 7:50 AM
7	1. Growing the program- increasing enrollment. 2. Balancing the needs of all students - some students have little computer experience and are lacking in basic skills, while others in the class have years of experience and are more advanced.	Oct 3, 2012 4:20 AM
8	Funding - to expand and offer more than one course	Sep 28, 2012 3:31 PM

Page 3, Q15. Do you think that geospatial programs should be accredited? (If Yes or No, also please comment, below)		
1	This may give GIS programs more credibility and support in the college environment (much like other accredited programs such as nursing and dental assisting).	Oct 4, 2012 11:12 PM
2	Personally, I do not think accreditation should matter in this case. However, my response is based on my observation that accrediation is used as a measurement of a programs' validity and standards.	Oct 3, 2012 6:31 PM
3	More funding for accredited programs.	Oct 3, 2012 7:50 AM

Page 3, Q16. Is there anything else that you would like to share with our group?		
1	I like the idea of micro-ceredentials. It would be very helpful if the chancellor's office provides us some support and incentive to build it at individual college and district-level. From student's point and for enrollment, having an approval/reconition of micro-credentials from the chancellor's office will be very helpful.	Oct 3, 2012 6:31 PM
2	I have lots of questions. How would students be tested to earn these micro-badges - would it be at the local CC level, or would the students take an exam and submit their work? If it's at the local CC level, what is the funding to administer the programs? Looking forward to the workshop!	Sep 28, 2012 3:31 PM

Go to the GTMC Competency Model

Enter course name(s) in the columns to the right; cut/paste for additional columns or delete as needed.
Enter 0 through 4 for each course based on the Scale Below
Refer to the "Definitions" tab in this worksheet for a explanation of how it should be included in the

○ 0 Not important for this course - do not include in this course
◔ 1 Slightly important for this course, include ony if time permits:
◑ 2 Important - include at an awareness level
◕ 3 Very Important; should be included at some level above awareness
● 4 Critical importance, must be included in depth

C#			101 - Intro to GST	102 - Spatial Analysis	103 -Data Acc & Mgmnt	104 - Cartogr. Design & Vis.	105 - Intro Remote Sensing	106 - Intro Geo Programming	107 - Geo Web Ap Dev	Competency Cluster
1	KNO	Explain how map scale affects data collection and management	◕ 3	◑ 2	◑ 2	◑ 2	◑ 2	○ 0	○ 0	Cross Cutting (CC)
2	A3.1	Create and build topology	◔ 1	◑ 2	◔ 1	○ 0	○ 0	○ 0	○ 0	Cross Cutting (CC)
3	T4	Describe the characteristics and appropriate uses of common coordinate systems, projections, Datums and geoids	◕ 3	◑ 2	◔ 1	◕ 3	◑ 2	○ 0	○ 0	Cross Cutting (CC)
4	C3	Validate spatial and tabular data (e.g. topology, build, verification)	◔ 1	◑ 2	◕ 3	○ 0	○ 0	◔ 1	○ 0	Cross Cutting (CC)
5	C	Define data's spatial reference	◕ 3	◑ 2	● 4	◔ 1	◕ 3	◑ 2	○ 0	Cross Cutting (CC)
6	C	Transform spatial data (e.g. reprojections)	◔ 1	◕ 3	◕ 3	◑ 2	◕ 3	◑ 2	○ 0	Cross Cutting (CC)
7	C	Apply appropriate projections	◕ 3	◕ 3	◑ 2	● 4	◕ 3	◕ 3	○ 0	Cross Cutting (CC)
8	KNO	Describe different methods of indicating locations (e.g., decimal degrees, UTM)	◕ 3	◑ 2	◕ 3	◑ 2	◔ 1	○ 0	○ 0	Cross Cutting (CC)
9	G	Calculate scale transformations.	◔ 1	◔ 1	◔ 1	○ 0	○ 0	○ 0	○ 0	Cross Cutting (CC)
10	G	Resolve spatial conflicts.	◑ 2	◑ 2	◔ 1	◕ 3	○ 0	○ 0	○ 0	Cross Cutting (CC)
11	G	Determine appropriate scale and projection	◕ 3	◑ 2	◔ 1	● 4	◑ 2	◕ 3	○ 0	Cross Cutting (CC)
12	T2	Number Operations and Computation - addition, subtraction, multiplication, and division	◑ 2	◑ 2	○ 0	◔ 1	◑ 2	○ 0	○ 0	Cross Cutting (CC)
13	T2	Number Systems and Relationships - whole numbers, decimals, fractions, and percentages	◑ 2	◑ 2	○ 0	◔ 1	◑ 2	○ 0	○ 0	Cross Cutting (CC)
14	T2	Measurement and Estimation - measurement of time, temperature, distances, length, width, height, perimeter, area, volume, weight, velocity, and speed; unit conversion; numerical analysis to obtain approximate solutions when necessary	◑ 2	◕ 3	○ 0	◔ 1	◑ 2	○ 0	○ 0	Cross Cutting (CC)
15	T2	Geometry - size, shape, and position of features using geometric principles to solve problems	◑ 2	◑ 2	○ 0	◔ 1	◑ 2	○ 0	○ 0	Cross Cutting (CC)
16	T2	Mathematical Reasoning and Problem Solving - inductive and deductive reasoning, conjectures, arguments, strategies, and interpretation of results	◔ 1	◑ 2	○ 0	○ 0	◑ 2	○ 0	○ 0	Cross Cutting (CC)
17	T2	Mathematical Notation - the language of mathematics to express mathematical ideas	○ 0	◑ 2	○ 0	○ 0	○ 0	○ 0	○ 0	Cross Cutting (CC)
18	T2	Algebra - equations, patterns, functions, 3D vectors, and matrices	◔ 1	◑ 2	○ 0	○ 0	◑ 2	○ 0	○ 0	Cross Cutting (CC)
19	T2	Trigonometry - relationships among the sides and angles of triangles on planes and spheres	◔ 1	◔ 1	○ 0	○ 0	◑ 2	○ 0	○ 0	Cross Cutting (CC)
20	H	Research GIS Technology Trends	◕ 3	◔ 1	◔ 1	◔ 1	◑ 2	◔ 1	○ 0	Conceptual Foundations (CF)
21	T4	Identify allied fields that rely on geospatial technology and that employ geospatial professionals	◑ 2	◔ 1	◔ 1	○ 0	○ 0	○ 0	○ 0	Conceptual Foundations (CF)
22	T5	Compare the capabilities and limitations of different types of geospatial software, such as CAD, GIS, image processing	◑ 2	◔ 1	◔ 1	○ 0	◔ 1	○ 0	◔ 1	Conceptual Foundations (CF)
23	T5	Compare benefits and shortcomings of desktop, server, enterprise, and hosted (cloud) software applications	◔ 1	◔ 1	○ 0	○ 0	○ 0	◕ 3	◑ 2	Conceptual Foundations (CF)

24	T4	Demonstrate understanding of the conceptual foundations on which geographic information systems (GIS) are based	3	2	2	1	1	0	0	Conceptual Foundations (CF)
25	T4	Demonstrate a working knowledge of GIS hardware and software capabilities, including GPS/GIS mapping systems	2	3	3	1	1	0	0	Conceptual Foundations (CF)
26	T2	Identify spatial patterns; apply knowledge of how people and places are linked	3	3	1	1	2	0	0	Conceptual Foundations (CF)
27	T2	Utilize internet an email applications	3	2	0	1	1	0	0	Conceptual Foundations (CF)
28	O	Utilize online help and other technical resources	2	3	3	2	4	3	0	Conceptual Foundations (CF)
29	T2	Apply geographic information relating to the Human–Environment Interaction,Regional Geography, Physical Geography, Cultural Geography	2	2	0	1	3	0	0	Conceptual Foundations (CF)
30	T2	Engineering Methods: Design technical plans, blueprints, drawings, and models.	0	0	0	0	0	0	0	Conceptual Foundations (CF)
31	T5	Employ cartographic techniques to represent different kinds of uncertainty, including uncertain boundary locations, transitional boundaries, and ambiguity of attributes	0	2	0	3	0	0	0	Cartography and Visualization (CV)
32	G	Describe purpose and use of maps	3	2	0	4	0	0	0	Cartography and Visualization (CV)
33	KNO	Describe different types of maps (e.g., road, terrain, choropleth)	3	1	0	4	0	0	0	Cartography and Visualization (CV)
34	G	Describe and apply appropriate symbology, fonts and colors	3	2	1	4	0	3	0	Cartography and Visualization (CV)
35	G	Determine appropriate map scale	3	2	1	4	1	3	0	Cartography and Visualization (CV)
36	G	Recognize and apply cartographic conventions	3	2	1	4	0	3	0	Cartography and Visualization (CV)
37	G	Design Cartographic Elements	2	1	0	4	0	3	0	Cartography and Visualization (CV)
38	G	Create maps using cartographic principles	3	2	1	4	0	3	0	Cartography and Visualization (CV)
39	G1	Perform Graphic Design	1	1	0	3	0	1	0	Cartography and Visualization (CV)
40	G	Create reference maps (e.g. streets)	3	1	1	4	0	3	0	Cartography and Visualization (CV)
41	G	Create thematic maps (e.g. zoning)	3	2	1	4	0	0	0	Cartography and Visualization (CV)
42	G	Create static and interactive maps	2	1	0	4	0	4	0	Cartography and Visualization (CV)
43	G	Design map layouts	3	2	1	4	0	3	0	Cartography and Visualization (CV)
44	G	Create map templates	2	1	0	3	0	1	0	Cartography and Visualization (CV)
45	G	Create graphic items (e.g. logos, headers, posters, exhibits) (E,C)	2	1	1	3	0	0	0	Cartography and Visualization (CV)
46	KNO	Demonstrate knowledge of map Interpretation.	3	2	1	4	1	0	0	Cartography and Visualization (CV)
47	G	Acknowledge contributors and copyrights	2	1	2	4	2	2	0	Cartography and Visualization (CV)
48	G	Adhere to purpose and use of maps	2	2	1	4	0	0	0	Cartography and Visualization (CV)
49	G2	Select proper media/output device	2	2	1	3	2	0	0	Cartography and Visualization (CV)
50	G	Create charts, graphs, tables	3	2	1	3	3	0	0	Cartography and Visualization (CV)
51	G	Create animations (e.g. 3D, 4D)	0	1	0	2	1	0	0	Cartography and Visualization (CV)
52	G5	Publish Map Products	1	1	1	3	0	3	0	Cartography and Visualization (CV)
53	B1	COGO legal descriptions (digitize using COGO e.g. meets & bounds	0	0	1	0	0	0	0	Generate Data (GD)
54	T2	Input Data	3	3	4	1	1	0	2	Generate Data (GD)
55	KNO	Describe the GNSS system and important concepts and uses	2	1	2	0	0	0	0	Generate Data (GD)
56	B2	Collect field data electronically	2	2	2	0	1	0	0	Generate Data (GD)
57	B3	Collect field data manually	1	1	2	0	1	0	0	Generate Data (GD)
58	B2	Collect field data using GPS (location and attribute)	2	1	2	0	1	0	0	Generate Data (GD)
59	B2.1	Explain how to use and coordinate geodetic control prior to mapping	1	1	1	0	0	0	0	Generate Data (GD)
60	B2.2	Post process GPS Data	0	1	2	0	0	0	0	Generate Data (GD)
61	T5	Explain the distinction between GNSS data post-processing and real time processing	1	1	2	0	0	0	0	Generate Data (GD)
62	B2.3	Assess current technologies used in data collection.	2	1	2	0	2	0	0	Generate Data (GD)

63	KNO	Apply appropriate map scale when creating or acquiring data	3	2	3	4	3	2	0	Generate Data (GD)
64	B2.4	Digitize data (tablet or heads up)	3	1	3	1	2	0	0	Generate Data (GD)
65	B2.5	Geocode data	3	1	3	0	0	0	0	Generate Data (GD)
66	B2.6	Scan non-digital data	1	1	3	0	1	0	0	Generate Data (GD)
67	KNO	Create TINs from feature data	1	2	1	0	0	0	0	Generate Data (GD)
68	KNO	Perform data format conversions (vector to raster, raster to vector)	1	3	3	2	2	0	0	Generate Data (GD)
69	T5	Explain GNSS data quality issues, such as multipath, PDOP, and signal-to-noise ratio	1	1	2	0	0	0	0	Generate Data (GD)
70	T5	Explain major GNSS error sources, such as ionospheric delay, clock error, ephemerides, and satellite health	1	1	2	0	0	0	0	Generate Data (GD)
71	T5	Explain the distinction between a property boundary and its representations, such as deed lines, lines on imagery, boundary depictions in cadastral databases	0	1	1	0	0	0	0	Generate Data (GD)
72	T5	Illustrate the differences between ellipsoidal (or geodetic) heights, geoidal heights, and orthometric elevation in relation to GNSS	0	1	1	0	0	0	0	Generate Data (GD)
73	T5	Produce an orthoimage data product with geometric accuracy suitable for project requirements	0	1	1	0	1	0	0	Generate Data (GD)
74	T5	Plot a legal boundary description from a deed or plat	0	0	1	0	0	0	0	Generate Data (GD)
75	T5	Plan a GNSS data acquisition mission that optimizes efficiency and data quality	0	0	2	0	0	0	0	Generate Data (GD)
76	T5	Perform requirements analysis for remotely sensed data acquisition using resolution concepts	0	1	1	0	3	0	0	Generate Data (GD)
77	T5	Explain the concept of "bit depth" and its implications for remotely-sensed image data	0	1	0	0	4	0	0	Generate Data (GD)
78	T5	Explain how spatial autocorrelation influences sampling strategies and statistics	0	1	1	0	1	0	0	Generate Data (GD)
79	T5	Identify and describe characteristics of inertial measurement systems and other geospatial measurement systems	0	0	2	0	1	0	0	Generate Data (GD)
80	T5	Collect and integrate carrier phase (survey grade) GNSS positions and associated attribute data with other geospatial data sets	0	0	1	0	0	0	0	Generate Data (GD)
81	T5	Plan a remotely sensed data acquisition mission, including specifying an appropriate sensor and platform combination suited for particular project requirements	0	0	1	0	2	0	0	Generate Data (GD)
82	T5	Make and justify a choice between Real time Standard Positioning Service (SPS) and Real time Precise Positioning Service (PPS) for a given objective	0	0	1	0	0	0	0	Generate Data (GD)
83	T5	Design a questionnaire and interview protocol for acquiring georeferenced socio-economic data	0	0	1	0	0	0	0	Generate Data (GD)
84	T5	Describe the components and operation of an aerotriangulation system	0	0	0	0	0	0	0	Generate Data (GD)
85	T5	Diagram the sequence of functions involved in producing georeferenced textual information harvested from social media sites and the World Wide Web	0	0	1	0	0	3	0	Generate Data (GD)
86	T5	Compare how land records are administrated in the U.S. in comparison with other developed and developing countries	0	0	1	0	0	0	0	Generate Data (GD)
87	T5	Design an integrated measurement system solution for acquiring and processing geospatial data	0	1	1	0	0	0	0	Generate Data (GD)
88	C1.2	Obtain imagery, basemap and terrain feature data	3	3	4	3	4	0	0	Generate Data (GD)
89	C1.3	Define data collection methods (e.g. GPS, air photo)	2	2	3	0	3	0	0	Generate Data (GD)
90	C1.4	Adhere to policies for sharing and receiving data	2	2	4	2	2	3	0	Generate Data (GD)
91	C3	Conduct Ground Truthing	1	1	2	0	3	1	0	Generate Data (GD)
92	C6	Demonstrate how to create/update data	3	2	4	0	0	0	3	Generate Data (GD)
93	C8	Georeference data	3	2	4	0	3	0	0	Generate Data (GD)

94	A1	Define data requirements (format, projections, etc.)	2	3	4	3	3	3	0	Manage Data (MD)
95	A2	Perform spatial and non-spatial data joins and link, join and relate tables	3	3	3	0	0	0	0	Manage Data (MD)
96	A3	Define feature behaviors and relationships	2	2	3	0	0	0	0	Manage Data (MD)
97	A4	Develop data maintenance schedule	0	0	3	0	0	0	0	Manage Data (MD)
98	A5	Establish data custodianships and permissions	0	0	2	0	0	1	0	Manage Data (MD)
99	A6	Evaluate how to verify spatial data accuracy, quality, compatibility and appropriateness for application	2	3	3	2	3	0	0	Manage Data (MD)
100	A7	Research and evaluate data sources	2	3	4	3	4	1	0	Manage Data (MD)
101	D5	Create and maintain data dictionary	2	1	4	0	0	0	0	Manage Data (MD)
102	D5	Define database fields	2	2	4	0	0	0	2	Manage Data (MD)
103	D5	Design Database Structure (e.g. schema)	1	2	3	0	0	0	0	Manage Data (MD)
104	D5	Develop (construct) databases (e.g. define geometry & attributes)	1	2	3	0	0	0	0	Manage Data (MD)
105	E5	Optimize database structure	1	1	3	0	0	0	0	Manage Data (MD)
106	E5	Optimize data file folders (Adv.)	0	1	2	0	0	0	0	Manage Data (MD)
107	E5	Conduct database performance tuning (e.g. compress, build stats, index) (C)	0	1	2	0	0	0	0	Manage Data (MD)
108	T4	Explain the relationship of horizontal datums to coordinate system grids and geometrix approximations of Earth's shape	3	2	1	3	1	0	0	Manage Data (MD)
109	KNO	Describe different data formats (Vector, Raster, TIN, etc.)	3	2	2	2	2	0	0	Manage Data (MD)
110	KNO	Apply appropriate data formats (Vector, Raster, TINs, Imagery)	3	3	1	3	2	1	0	Manage Data (MD)
111	C1	Acquire data	3	3	4	2	3	0	2	Manage Data (MD)
112	T4	Critique the design of a given map in light of its intended audience and purpose	2	2	1	4	0	2	0	Manage Data (MD)
113	T4	Acquire and integrate a variety of field data, image data, vector data, and attribute data to create, update, and maintain GIS databases	3	2	4	1	2	0	0	Manage Data (MD)
114	C2.1	Organize file structure (e.g. create directories, perform data & directory housekeeping	2	3	2	1	3	0	0	Manage Data (MD)
115	C2.2	Create directory structure	3	3	2	1	3	2	2	Manage Data (MD)
116	C2.3	Create naming conventions	4	3	2	1	3	0	3	Manage Data (MD)
117	C2.4	Normalize data structure (e.g. schema)	2	2	3	0	0	0	0	Manage Data (MD)
118	C2.5	Organize digital and non-digital data (e.g. data library)	2	2	2	1	2	0	0	Manage Data (MD)
119	C3	Describe Quality Assurance / Quality Control for acquiring and maintain data	2	2	3	0	3	1	0	Manage Data (MD)
120	C3	Verify content and spatial accuracies of data	1	2	3	2	3	0	0	Manage Data (MD)
121	C3	Demonstrate how to Archive and Backup Data	2	2	3	0	1	0	3	Manage Data (MD)
122	C5	Demonstrate how to Import/Export data from various sources (e.g. spreadsheets)	3	3	3	1	1	2	3	Manage Data (MD)
123	C5	Demonstrate how to connect to external data sources (e.g. odbc, GIS servers)	2	2	3	1	1	3	2	Manage Data (MD)
124	C5	Describe how to export data in transferable format	2	2	3	0	2	3	3	Manage Data (MD)
125	C5	Edit and update attribute and spatial data	3	3	4	0	1	1	3	Manage Data (MD)
126	C6	Update spatial and non-spatial data attributes	3	3	4	0	0	0	0	Manage Data (MD)
127	C6	Edit feature geometry	3	2	4	0	0	0	0	Manage Data (MD)
128	C6	Post / reconcile edits (e.g. changes)	1	1	4	1	0	2	0	Manage Data (MD)
129	C7	Create/update metadata	3	2	4	2	3	0	0	Manage Data (MD)
130	C	Rectify raster data (e.g. rubbersheeting)	1	2	3	0	3	0	0	Manage Data (MD)
131	C9	Explain conversion of digital formats - data abstraction (cut, simplify, stretch & fit)	1	2	3	0	0	1	0	Manage Data (MD)
132	C	Convert data between formats (e.g. KML, XML, RSS) (Adv.)	2	2	3	2	3	3	0	Manage Data (MD)
133	G	Create Database Tables	3	2	3	0	0	0	3	Manage Data (MD)

134	E1	Develop software applications	0	0	0		0	0	0	4	Programming & Application Design (PA)
135	E	Test application performance	0	0	0		0	0	4	3	Programming & Application Design (PA)
136	E	Determine programming tools required to develop applications	0	0	0		0	0	3	3	Programming & Application Design (PA)
137	E	Develop application to simplify and/or standardize procedures	0	1	0		0	0	4	4	Programming & Application Design (PA)
138	E	Exercise quality control (Application Dev't)	0	0	0		0	0	3	0	Programming & Application Design (PA)
139	E2	Automate Manual Processes	0	1	1		0	0	0	4	Programming & Application Design (PA)
140	E	Automate repetitive tasks	1	1	1		0	0	0	4	Programming & Application Design (PA)
141	E	Create scripts	0	1	0		0	0	3	4	Programming & Application Design (PA)
142	KNO	Modify basic scripts	0	1	0		0	0	4	4	Programming & Application Design (PA)
143	E	Determine application design format (e.g. platform, language)	0	0	0		0	0	3	3	Programming & Application Design (PA)
144	E	QA/QC software applications (e.g. beta test)	0	0	0		0	0	3	3	Programming & Application Design (PA)
145	KNO	Use appropriate programming languages (e.g.,SQL, VB, HTML, Python, etc.)	0	1	0		0	0	4	4	Programming & Application Design (PA)
146	E	Enhance existing custom applications	0	0	0		0	0	4	3	Programming & Application Design (PA)
147	KNO	Apply basic programming Principles (SQL statements, Boolean logic, macros)	1	2	1		0	0	1	3	Programming & Application Design (PA)
148	E	Determine hardware /software requirements/ constraints	1	1	1		0	0	1	0	Programming & Application Design (PA)
149	E	Select database software (performance, usability, cost, manageability, uses, output format)	0	1	1		0	0	0	0	Programming & Application Design (PA)
150	E	Provide Technology Recommendations	0	1	0		0	0	0	0	Programming & Application Design (PA)
151	E	Recommend new technologies	0	1	0		0	0	0	0	Programming & Application Design (PA)
152	E4	Describe how a user should maintain software	1	0	0		0	0	0	0	Programming & Application Design (PA)
153	E	Produce application recommendation files	0	0	2		0	0	0	0	Programming & Application Design (PA)
154	H	Demonstrate how to build help files	0	0	0		0	0	0	0	Programming & Application Design (PA)
155	H	Write Technical Guides	0	0	0		0	0	0	0	Programming & Application Design (PA)
156	H	Create "read me" files	1	1	1		0	0	0	1	Programming & Application Design (PA)
157	T5	Employ query languages such as SQL to interrogate spatial databases	1	2	2		0	0	3	3	Programming & Application Design (PA)
158	T5	Identify the components of a GIS	1	1	1		0	0	0	0	Programming & Application Design (PA)
159	T5	Recognize GIS tasks that are amenable to automation, such as route generation, incident response, and land use change analysis	0	1	0		0	0	0	3	Programming & Application Design (PA)
160	T5	Recognize opportunities to leverage positioning technology to create mobile end-user applications	0	1	0		0	0	3	1	Programming & Application Design (PA)
161	T5	Work effectively in teams to plan and coordinate software and application development	0	1	0		0	0	1	3	Programming & Application Design (PA)
162	T5	Communicate effectively with end-users to ensure that software applications meet user needs	0	0	0		0	0	1	3	Programming & Application Design (PA)
163	T5	Demonstrate understanding of common geospatial algorithms, such as geocoding or drive time analysis, by writing or interpreting pseudo code	0	1	0		0	0	1	3	Programming & Application Design (PA)
164	T5	Identify the factors that affect the interoperability of geospatial software applications	0	0	1		0	0	2	0	Programming & Application Design (PA)
165	T5	Use scripting languages such as JavaScript, PHP, and KML to create web mapping applications	0	0	0		0	0	3	3	Programming & Application Design (PA)
166	T5	Evaluate open source software components for re-use and potential return contributions	1	0	0		0	0	0	0	Programming & Application Design (PA)
167	T5	Identify alternatives for customization and automation, such as APIs, SDKs, scripting languages	0	0	0		0	0	1	3	Programming & Application Design (PA)
168	T5	Identify appropriate software development tools for particular end uses	0	0	0		0	0	1	0	Programming & Application Design (PA)
169	T5	Customize geospatial software using proprietary and open source software components, such as ESRI's ArcObjects, Intergraph's GeoMedia software suite, and the GeoTools open source project	0	0	0		0	0	0	3	Programming & Application Design (PA)
170	T5	Design a geospatial system architecture that responds to user needs, including desktop, server, and mobile applications	0	0	0		0	0	0	0	Programming & Application Design (PA)

171	T5	Realize opportunities to leverage positioning technology to create mobile end-user applications	0	0	0	0	0	0	2	1	Programming & Application Design (PA)
172	T5	Explain how geospatial software in large enterprises fits into SOA (Service Oriented Architectures) and SaaS (Software as a Service)	0	0	0	0	0	0	3	0	Programming & Application Design (PA)
173	T5	Ensure that software code complies with industry standards, such as those promulgated by the Open Geospatial Consortium (OGC)	0	0	0	0	0	0	1	0	Programming & Application Design (PA)
174	T5	Optimize geospatial system performance	0	0	0	0	0	0	3	0	Programming & Application Design (PA)
175	T5	Create geospatial software programs using programming languages such as C, C++, and Java	0	0	0	0	0	0	0	0	Programming & Application Design (PA)
176	C1.1	Determine data needs and format	3	3	3	3	3	3	0	0	Project Management (PM)
177	C2.7	Organize written information (i.e., reports, resumes).	2	2	2	0	0	1	0	0	Project Management (PM)
178	E	Install Software (e.g. enhancements, service packs) (C)	1	0	0	0	0	0	2	0	Project Management (PM)
179	E	Comply with software licensing agreements	1	1	0	0	0	0	1	0	Project Management (PM)
180	E5	Describe how to Install software upgrades	1	1	0	0	0	0	2	0	Project Management (PM)
181	E	Maintain workstation security	0	1	1	0	0	0	0	0	Project Management (PM)
182	E	Recommend software upgrades	0	1	0	0	0	0	0	0	Project Management (PM)
183	E	Make project recommendations	0	1	2	0	0	0	0	0	Project Management (PM)
184	E	Conform to policy and standards	0	1	4	0	0	0	1	0	Project Management (PM)
185	T2	Identify the Problem	3	2	2	0	0	3	0	3	Project Management (PM)
186	T2	Formulate problem, collect data through observation and the formulation and testing of a hypothesis	2	3	2	0	0	3	0	3	Project Management (PM)
187	T2	Choose and Implement a Solution	3	3	2	3	3	3	0	4	Project Management (PM)
188	T2	Generate Alternatives	2	2	2	3	3	3	0	3	Project Management (PM)
189	F1	Describe how to coordinate project activities	2	2	2	0	0	0	0	2	Project Management (PM)
190	KNO	Apply principles of geography to projects	2	3	1	2	2	2	0	0	Project Management (PM)
191	KNO	Describe different applications and uses of geospatial technology	3	2	1	0	0	1	0	0	Project Management (PM)
192	KNO	Apply critical thinking and problem solving skills when developing a project	3	3	2	3	3	3	0	4	Project Management (PM)
193	F	Monitor project progress and verify that project goals are met	2	2	2	0	0	2	0	0	Project Management (PM)
194	KNO	Describe some common industry standards for geospatial technology (e.g. ISO 9000, metadata, etc.)	1	1	4	0	0	0	1	0	Project Management (PM)
195	F	Explain how to coordinate with a Project Team, stakeholders, consultants and IT	0	1	0	0	0	0	0	0	Project Management (PM)
196	F	Describe how to maintain contracts	0	0	0	0	0	0	0	0	Project Management (PM)
197	F	Develop Project Plan	1	1	2	0	0	0	0	0	Project Management (PM)
198	F	Define project scope	1	2	2	0	0	0	0	0	Project Management (PM)
199	F	Establish project standards	1	2	2	0	0	0	0	0	Project Management (PM)
200	F	Document Project results	2	2	2	0	0	3	0	3	Project Management (PM)
201	F	Determine resource requirements	1	1	1	0	0	0	0	0	Project Management (PM)
202	F	Conform to policy and standards	1	1	2	3	0	0	0	0	Project Management (PM)
203	KNO	Describe how copyright laws may apply to data and projects	1	1	2	3	0	0	2	1	Project Management (PM)
204	F4	Develop/document procedures and guidelines	2	2	2	0	0	2	0	0	Project Management (PM)
205	F	Prepare budget and cost estimates (e.g., time, equipment, data acquisition)	0	1	1	0	0	0	0	0	Project Management (PM)
206	F	Determine project timeline (schedule, priorities, workload)	1	1	1	0	0	0	0	0	Project Management (PM)
207	F	Determine project needs (e.g., client needs)	1	2	2	0	0	0	1	0	Project Management (PM)
208	T2	Act in the best interests of the company, your co-workers and your community.	1	1	1	2	0	0	1	0	Project Management (PM)

209	G1	Define project Deliverables	2	2	1		2	2	0	0	Project Management (PM)
210	G	Create reports on analysis, project status, outcomes, etc.	2	3	1		1	3	0	0	Project Management (PM)
211	G3	Create and present geospatial projects	1	3	1		2	3	0	0	Project Management (PM)
212	G	Present project summary	3	2	1		2	3	0	0	Project Management (PM)
213	G	Provide information presentations	3	2	1		2	3	0	0	Project Management (PM)
214	G	Disseminate documentation where appropriate	1	1	2		0	0	0	3	Project Management (PM)
215	G4	Disseminate information through a web site	1	1	0		1	0	4	1	Project Management (PM)
216	G	Load/Burn Data onto Media	1	1	3		1	0	0	0	Project Management (PM)
217	G	Distribute data according to organizational policy (E,C)	1	1	4		0	0	3	0	Project Management (PM)
218	G	Communicate with peers, clients, co-workers	3	3	2		1	1	1	0	Project Management (PM)
219	G	Communicate quality control problems to other team members.	1	2	3		0	1	0	0	Project Management (PM)
220	G	Present ideas clearly and concisely.	3	3	2		3	2	0	1	Project Management (PM)
221	G	Inform data users and custodians of update completion	1	1	2		0	0	0	0	Project Management (PM)
222	H	Develop users guides	0	0	1		0	0	0	0	Project Management (PM)
223	H	Troubleshoot hardware/software problems	0	1	0		0	0	3	1	Project Management (PM)
224	T5	Perform a feasibility study and cost/benefit analysis	0	1	0		0	0	0	1	Project Management (PM)
225	T5	Develop use cases for user-centered requirements analyses	0	0	0		0	0	0	0	Project Management (PM)
226	T2	Use Writing and Publishing Applications	1	1	0		1	0	0	0	Project Management (PM)
227	G	Visit trade shows	0	1	0		0	0	0	0	Professionalism ((PR)
228	H1	Network with industry professionals	1	1	0		0	0	0	0	Professionalism ((PR)
229	H	Participate in professional organizations, workshops and conferences	1	1	0		1	1	0	0	Professionalism ((PR)
230	H	Describe possible types of training events availabe to workforce	1	1	0		0	0	0	0	Professionalism ((PR)
231	H	Describe possible types of certification available to geospatial occupations	1	1	0		0	0	0	0	Professionalism ((PR)
232	H	Resolve user technical problems	0	1	1		0	0	0	0	Professionalism ((PR)
233	H	Review industry publications	1	1	1		0	0	0	0	Professionalism ((PR)
234	H	View job related information (e.g. blogs, news feeds, print publications, forums)	1	1	1		0	0	0	0	Professionalism ((PR)
235	KNO	Describe how a code of ethics may be part of a geospatial profession	1	1	0		3	0	0	0	Professionalism ((PR)
236	T4	Identify legal, ethical, and business considerations of geospatial data	1	1	3		2	0	0	0	Professionalism ((PR)
237	H7	Promote/Represent GIS	1	1	0		0	0	0	0	Professionalism ((PR)
238	H5	Attend Training	1	1	1		0	0	0	0	Professionalism ((PR)
239	D3	Conduct image analysis (e.g. classification)	1	2	0		0	4	0	0	Remote Sensing and Imagery (RS)
240	D	Classify remote sensing data (reclassify, supervised, unsupervised)	1	2	0		0	4	0	0	Remote Sensing and Imagery (RS)
241	D	Develop orthophotography	1	1	0		0	1	0	0	Remote Sensing and Imagery (RS)
242	D	Interpret Imagery	1	2	0		0	4	0	0	Remote Sensing and Imagery (RS)
243	T5	Determine appropriate image data and image analysis techniques needed to fulfill project requirements	1	3	1		0	4	0	0	Remote Sensing and Imagery (RS)
244	KNO	Create composite images (true, false, NDVI)	1	1	0		0	4	0	0	Remote Sensing and Imagery (RS)
245	KNO	Describe basic concepts and use of photogrammetry	1	1	0		0	4	0	0	Remote Sensing and Imagery (RS)
246	KNO	Describe basic concepts and use of remote sensing images	2	1	1		0	4	0	0	Remote Sensing and Imagery (RS)
247	T5	Explain the difference between pixel-based and object-based image classification	1	1	1		0	3	0	0	Remote Sensing and Imagery (RS)
248	T5	Evaluate the thematic accuracy of a data product derived from aerial image interpretation, such as a soils map, using ground verification methods	0	2	2		0	3	0	0	Remote Sensing and Imagery (RS)

249	T5	Explain how to quantify the thematic accuracy of a land use/land cover map derived from remotely-sensed imagery	0	1	1		0	4	0	0	Remote Sensing and Imagery (RS)
250	T5	Perform object-oriented image classification using specialized software tools	0	1	0		0	3	0	0	Remote Sensing and Imagery (RS)
251	T5	Outline workflows that identify sequence of procedures involved in geometric correction, radiometric correction, and mosaicking of remotely sensed data	0	0	1		0	4	0	0	Remote Sensing and Imagery (RS)
252	T5	Define the sampling theorem in relation to the concept of spatial resolution of remotely-sensed imagery	0	1	0		0	1	0	0	Remote Sensing and Imagery (RS)
253	RS	Define Spectral signatures for classification	0	0	0		0	4	0	0	Remote Sensing and Imagery (RS)
254	RS	Transform images (PCA, vegetation indices, band ratios)	0	0	0		0	4	0	0	Remote Sensing and Imagery (RS)
255	RS	Create ratio images (NDWI, NDVI, MSI, LAI, EVI, snow, etc.)	0	0	0		0	4	0	0	Remote Sensing and Imagery (RS)
256	RS	Filter image (edge enhancement, smoothing)	0	0	0		0	4	0	0	Remote Sensing and Imagery (RS)
257	RS	Perform image segmentation	0	0	0		0	3	0	0	Remote Sensing and Imagery (RS)
258	RS	Conduct image subtraction (single bands or image transforms)	0	0	0		0	4	0	0	Remote Sensing and Imagery (RS)
259	RS	Mosaic image/data	0	0	0		0	4	0	0	Remote Sensing and Imagery (RS)
260	RS	Perform atmospheric correction	0	0	0		0	2	0	0	Remote Sensing and Imagery (RS)
261	RS	Perform radiometric correction	0	0	0		0	2	0	0	Remote Sensing and Imagery (RS)
262	RS	Perform image enhancement (pan sharpening, tonal balance, etc.)	0	0	0		0	3	0	0	Remote Sensing and Imagery (RS)
263	RS	Identify appropriate band combinations for display	0	0	0		0	4	0	0	Remote Sensing and Imagery (RS)
264	RS	Perform change detection	0	0	0		0	4	0	0	Remote Sensing and Imagery (RS)
265	RS	Create a difference image (math tools)	0	0	0		0	4	0	0	Remote Sensing and Imagery (RS)
266	RS	Conduct trend analysis	0	0	0		0	2	0	0	Remote Sensing and Imagery (RS)
267	RS	Perform regression analysis	0	0	0		0	1	0	0	Remote Sensing and Imagery (RS)
268	RS	Perform vector (feature) extraction	0	0	0		0	4	0	0	Remote Sensing and Imagery (RS)
269	RS	Perform object-based image analysis	0	0	0		0	3	0	0	Remote Sensing and Imagery (RS)
270	RS	Perform orthorectification	0	0	0		0	1	0	0	Remote Sensing and Imagery (RS)
271	RS	Create intensity image (LiDAR)	0	0	0		0	1	0	0	Remote Sensing and Imagery (RS)
272	RS	Collect spectral signatures for imagery classification.	0	0	0		0	4	0	0	Remote Sensing and Imagery (RS)
273	D1	Conduct Geoprocessing (e.g. clip, buffering, overlay, run models, map algebra)	2	4	1		2	4	3	3	Spatial Analysis and Modeling (SM)
274	T5	Perform Basic Analytical Methods (point pattern analysis, cluster analysis, multi-criteria evaluation, and spatial process models	1	3	1		2	0	0	0	Spatial Analysis and Modeling (SM)
275	D	Observe and report data anomalies	2	2	3		0	2	0	0	Spatial Analysis and Modeling (SM)
276	D	Perform buffer analysis	2	4	1		0	0	0	0	Spatial Analysis and Modeling (SM)
277	D	Conduct slope analysis	1	4	0		0	0	0	0	Spatial Analysis and Modeling (SM)
278	D	Derive new data (e.g. generate contours from DEM, data generalization)	1	4	2		2	4	0	0	Spatial Analysis and Modeling (SM)
279	D	Perform overlay analysis.	2	4	0		0	0	0	0	Spatial Analysis and Modeling (SM)
280	D	Perform proximity analysis	2	4	0		0	0	0	0	Spatial Analysis and Modeling (SM)
281	D	Perform site selection	2	3	0		0	0	0	0	Spatial Analysis and Modeling (SM)
282	D	Perform view shed analysis	1	3	0		0	0	0	0	Spatial Analysis and Modeling (SM)
283	D	Create Models (e.g. process & scientific models, flow charts)	1	4	0		0	3	0	3	Spatial Analysis and Modeling (SM)
284	D	Interpret Results from analysis (is it appropriate/good)	2	3	0		3	4	0	0	Spatial Analysis and Modeling (SM)
285	D	Pre-process Data (e.g. generalize, subset)	1	3	3		2	4	3	0	Spatial Analysis and Modeling (SM)
286	D	Interpret topography (i.e., contour lines).	2	3	2		0	0	0	0	Spatial Analysis and Modeling (SM)
287	D2	Identify least-cost path	1	2	0		0	0	0	0	Spatial Analysis and Modeling (SM)

288	D	Perform network analysis (dynamic segmentation)	0	2	0		0	0	0	0	Spatial Analysis and Modeling (SM)
289	D	Identify shortest/optimal route that accounts for visibility, slope, and specified land uses	1	2	0		0	0	0	0	Spatial Analysis and Modeling (SM)
290	D	Conduct segmentation with linear reference data	0	2	0		0	0	0	0	Spatial Analysis and Modeling (SM)
291	D	Model linear networks	0	1	0		0	0	0	0	Spatial Analysis and Modeling (SM)
292	D	Conduct network analysis	1	2	0		0	0	0	0	Spatial Analysis and Modeling (SM)
293	D4	Conduct geostatistical analysis	0	3	0		0	1	0	0	Spatial Analysis and Modeling (SM)
294	D	Perform statistical analysis	1	3	0		0	3	0	0	Spatial Analysis and Modeling (SM)
295	D5	Apply principles of computational geometry.	0	2	0		0	0	0	0	Spatial Analysis and Modeling (SM)
296	D	Use sampling techniques (eg. random, stratified, etc.)	0	2	3		0	1	0	0	Spatial Analysis and Modeling (SM)
297	D2	Perform Queries	4	3	1		0	0	3	3	Spatial Analysis and Modeling (SM)
298	T5	Explain how leading online routing systems work, and account for common geocoding errors	0	1	1		0	0	0	0	Spatial Analysis and Modeling (SM)
299	T5	Geostatistics, including spatial sampling, semi-variogram modeling, and kriging	0	2	0		0	0	0	0	Spatial Analysis and Modeling (SM)
300	T5	Data Mining, including pattern recognition	0	2	3		0	2	0	0	Spatial Analysis and Modeling (SM)
301	T5	Use location-allocation software functions to locate service facilities that satisfy given constraints	0	1	0		0	0	0	0	Spatial Analysis and Modeling (SM)
302	T5	Assess the current state of the art in coupling predictive models and simulations with GIS software	0	1	0		0	0	0	0	Spatial Analysis and Modeling (SM)
303	T5	Explain the Modifiable Areal Unit Problem in relation to the "ecological fallacy"	0	1	0		0	0	0	0	Spatial Analysis and Modeling (SM)
304	T5	Compare characteristics and appropriate uses of geospatial modeling techniques, such as neural networks, cellular automata, heuristics, agent-based models, and simulation models such as Monte Carlo simulation	0	1	0		0	0	0	0	Spatial Analysis and Modeling (SM)
305	H	Explore new geoprocessing techniques	1	2	0		0	0	0	0	Spatial Analysis and Modeling (SM)
306	T4	Specify uses of standard non-spatial data models, specifically the relational data model and its extensions	1	2	2		0	0	0	0	Spatial Analysis and Modeling (SM)
307	KNO	Describe the basic concepts and techniques that are used in surveying to collect and store data	1	1	2		0	0	0	0	Surveying (SU)
308	T5	Establish, re-establish and/or monument property boundaries; represent such boundaries in plats, records, and descriptions, all under personal and professional liability as stipulated in legal statute and precedent	0	0	0		0	0	0	0	Surveying (SU)
309	G	Manage Web Content	0	0	1		1	0	3	0	Server and the Web (SW)
310	G	Publish spatial information on-line	1	1	1		3	0	4	0	Server and the Web (SW)
311	T5	Utilize new architectural opportunities such as cloud computing	1	1	3		0	0	3	0	Server and the Web (SW)