

CALIFORNIA STATE UNIVERSITY, NORTHRIDGE

CREATING A SECONDARY SCHOOL LEVEL GIS PROGRAM

A thesis submitted in partial fulfillment of the requirements  
For the degree of Master of Arts in Geography, GIS Program

By

Dominique Evans

May, 2012

The thesis of Dominique Evans is approved:

\_\_\_\_\_  
James W. Craine, Ph.D. \_\_\_\_\_  
Date

\_\_\_\_\_  
Steven Graves, Ph.D. \_\_\_\_\_  
Date

\_\_\_\_\_  
Shawna J. Dark, Ph.D., Chair \_\_\_\_\_  
Date

## ACKNOWLEDGEMENTS

This project was made possible in part by the Principal of Clark Magnet High School, Doug Dall, and his willingness to allow me to create a series of new science elective courses focusing on Geographic Information Science instruction. I am grateful for the collaborative efforts of my co-worker, Alex Day-Blattner in developing the team-taught course, *The Geology of Disasters*. A special thank you goes to Esri Education Manager, Charlie Fitzpatrick, for his years of advice, support and access to software that has changed the lives of so many of my students. I also thank Glendale Unified School District Teacher Specialist, Bonnie Gould for retrieving years of test score data for my assessment analysis. I also thank all my students who joyfully engaged in learning GIS software and for their enthusiastic participation during that learning process.

A special thanks to my thesis committee for all their advisement and for the time they put in reading over this thesis. Their comments and suggestions were greatly appreciated. I'd like to thank my family and friends for their patience during this extended period of near isolation on my part. I can't thank my mom, Diane Betzler, and my co-worker Anne Reinhard enough for their time proof-reading my first draft for grammar and spelling. My husband, Lauris Bye, helped me immensely by showing me tricks and techniques to format the paper in order to meet the Thesis requirements.

I want to thank the Toyota Motor Corporation, Lexus of Glendale, UCLA Center X, and the Society for Science and the Public for their financial support of my program. The Marine Technology Society, California State University, Northridge Graduate Studies Program and the Geography Department provided personal awards that made participation in the graduate program possible. Because of the support from all my program partners, this project will continue to develop and impact the future of many students.

## TABLE OF CONTENTS

Signature Page	ii
Acknowledgements	iii
List of Tables	vi
List of Figures	vii
Abstract	viii
Chapter 1: Introduction	1
Role of CTE	1
GIS in Schools	3
GIS Program at Clark Magnet High School	4
Chapter 2: Methods	8
Development and Implementation	8
Marine Science Research	9
Environmental GIS	10
The Geology of Disasters; a Hazus-MH Training Course	12
Assessment	14
Chapter 3: Results	16
Marine Science Research (A.K.A. Robotics GIS)	16
Environmental GIS	17
Geology of Disasters; a Hazus-MH Training Course	18
Partnerships	19
Assessment	21
Chapter 4: Discussion / Conclusion	34
Vision and Roadblocks	35
Pedagogy	39
Science, Technology, Engineering, Arts, Mathematics	43
Future Steps for Clark Magnet High School	43

References	45
Appendix A: GUSD Course Outline EnvGIS	47
Appendix B: GUSD Course Outline GOD A	51
Appendix C: GUSD Course Outline GOD B	56
Appendix D: LACOE ROP Course Outline EnvGIS	61
Appendix E: UC “A-G” Course Outline GOD	79

LIST OF TABLES

Table 1

20

## LIST OF FIGURES

Figure 1	22
Figure 2	23
Figure 3	24
Figure 4	24
Figure 5	25
Figure 6	26
Figure 7	27
Figure 8	27
Figure 9	28
Figure 10	29
Figure 11	30
Figure 12	30
Figure 13	31
Figure 14	32
Figure 15	32
Figure 16	33

## ABSTRACT

### CREATING A SECONDARY SCHOOL LEVEL GIS PROGRAM

By

Dominique Evans

Master of Arts in Geography, GIS Program

The purpose of this thesis is to develop a geographic information science (GIS) program of instruction, implement the program and assess the impact of the program on students at Clark Magnet High School. California Standards data will be analyzed to test the null hypothesis that there is no difference between the test scores of Clark Magnet High School students who have taken a GIS class verses Clark Magnet students who have not taken a GIS class. During the course of this thesis, three unique GIS courses were created and implemented at Clark Magnet High School; Marine Science Research, Environmental GIS and The Geology of Disasters; A Hazus-MH Training Course. All three courses have been approved by the Glendale Unified School District and have been adopted by the Los Angeles County Regional Occupation Program. One course, The Geology of Disasters, has received University of California “g” science elective approval. California Standard Test results indicate higher performance in the Investigation/Experimentation science cluster for students enrolled in a GIS class at Clark Magnet over those who have not had a GIS course. The myriad of successes our GIS-trained students have achieved during science competitions reinforce the conclusion that GIS instruction has a positive impact on the academic performance of Clark Magnet High School students.



## CHAPTER 1: INTRODUCTION

### Role of CTE

Career Technical Education (CTE) brings consistent real-life application to academic instruction, by teaching students how to connect what is taught in the classroom to a working career. Core academic subjects such as Math, English, Science and the Social Sciences provide essential skills necessary for an educated workforce. Students, however, rarely connect these subjects with any personal relevancy for use in their lives. Many students often find school boring and irrelevant to their future (Brand, 2003). For instance, students don't sit in Math, English or History class and think, "I can get a job in this subject." This thesis proposes that geographic information science (GIS) classes embedded throughout high school curriculum increase students' interest in school, engage students in using multiple sources of knowledge to solve complex problems, and provide students with marketable skills to use throughout their lives. California Standards data will be analyzed to test the null hypothesis that there is no difference between the test scores of Clark Magnet High School students who have taken a GIS class verses Clark Magnet students who have not taken a GIS class.

Historically, CTE classes have been aimed toward students who are not pursuing higher education. Traditional CTE courses included classes like Auto Shop, Cosmetology or Woodworking, all designed to train a blue collar workforce by giving them entry-level skills. The goal was to enable students to successfully enter the job market. In 2003, Betsy Brand wrote a paper on CTE reform and stated, "The past division between preparation for college and preparation for work has become a false dichotomy." Brand believes that all students should be held to high standards in secondary and postsecondary education in order to be prepared to enter society as a good citizen, to continue learning, and to be prepared for career challenges. American students are deemed to be so lacking in preparedness for college and career that a National Education Summit on High Schools convened in 2005 to deal specifically with that issue. As a result of that summit, A progress report on the alignment of high school policies with the demands of college and careers is released/published annually. (Achieve 2011)

Recently, higher education has taken an interest in the development of CTE programs. At the University of California, they have developed a Curriculum Integration Project that recognizes the need for rigorous instruction integrating CTE and academic curriculum to bring relevancy into education. In this model, CTE instructors work together with academic high school teachers to integrate core standards and CTE standards, and thereby show students a true application of academics in a career. For example, the University of California has approved a “Business Statistics” class. This course is a Business Financial Management CTE course that integrates with an Advanced Placement high school statistics class, in order to infuse core foundational math concepts with relevant career technical elements.

The value of CTE is that students can see themselves in a career when they actively participate in the workings of that career. In the science field, for instance, working as a professional biologist does not involve reading a textbook, filling out worksheets or answering questions from the end of each chapter. Unfortunately many students can’t think of biology beyond what is presented to them in school. Biology has many fun and exciting career applications that often don’t get communicated through traditional classroom instruction. For example, a CTE integrated biology class could incorporate forensics, made popular through current television programs, throughout the curriculum, to add interest and relevance to the class. “When students apply academic subject matter in out-of-school contexts, they deepen their understanding and retention of academic concepts and thereby increase their academic achievement” (Saunders and Chrisman, 2011). Using this model, students tend to stay more interested in school and have higher graduation rates (Brand 2003, Bishop 2004, Saunders and Chrisman, 2011).

Preparing students for the future is an issue of critical importance. To address this issue, Common Core State Standards were developed with college and career readiness in mind. These standards build a progression of learning throughout the K-12 experience to promote student success. “They are grounded in evidence about what it takes for high school graduates to be ready for college and careers and build on the finest state and international standards.” (Achieve 2011) The National Governors Association and the Council of Chief State School Officers led the development of these standards for the states through a partnership with Achieve.

The National Education Policy Center promotes a reform known as “Linked Learning.” This approach connects rigorous academic education with CTE, and adopts a “College-as-an-option-for-all” strategy. This tactic helps prepare students for the workforce while showing how higher education benefits a career/careers. (Saunders and Chrisman, 2011) Linked Learning bridges the false dichotomy identified by Brand in her 2003 American Youth Forum paper. Under this model, students don’t have to choose between college or work at a time in their lives when they are not best prepared to make irrevocable decisions. (Saunders and Chrisman, 2011) It is often said, there is a difference between knowledge and wisdom, or in other words, between book smart and street smart. CTE can provide experience to foster important cognitive abilities of both types, as well as other competencies critical for success at work, school and life as a whole.

### **GIS in Schools**

Geographic Information Science education fits perfectly with the Linked Learning model. GIS is applied across disciplines, and can enhance education in all core academic subjects. CTE focused on GIS can benefit students regardless of the college major or career path they choose. Applying GIS lessons to academic subjects across the curriculum fully integrates a pathway of learning that can translate into any college major and culminate in a lifelong career. According to the Ohio University Academic Advising page, students change their major an average of three times. A strong background in GIS is not likely to be wasted regardless of changing majors or career paths. This is illustrated by the annual *Esri Map Book*, published from entries displayed in the poster gallery at the International Users Conference. Over 150 countries and numerous industries have been represented at this event since 1981. (Fitzpatrick, Pers. Com.)

Building a GIS pathway from K-12 education through postsecondary institutions will reinforce GIS instruction so it is no longer something they’ve learned, it’s something they do. A continuing education in GIS will also keep students’ skills up to date with the latest software which will offer graduates a competitive advantage in their job search. Instruction in GIS lends itself to a self-directed and self-paced format. Students who have grown up around computers quickly learn the basics. For students who have little access to computers at home, GIS helps foster basic computer literacy (Esri 1995). Critical thinking is developed as students learn to use geoprocessing tools for data analysis. Students become active

researchers as they gather data, prepare their data for analysis, organize storage of their data and choose appropriate geoprocesses for analysis of their data, and finally format data for presentation. With GIS, students use Science, Technology, Engineering and Mathematics (STEM). GIS, however, is not limited to STEM. Map-making encourages artistic expression (Esri 1995). Cartography teaches the use of color, balance and hierarchy of features to communicate information. An aesthetic product draws interest. A map that is attractive and easily understood is more likely to be consulted over one that does not follow basic cartographic principles. Throughout this process, Science, Technology, Engineering, Art and Mathematics (STEAM) learning is reinforced.

Today's students take a greater interest in projects that benefit the environment or their community; they are empowered to make a difference. GIS is a perfect match with project-based learning and service learning projects. "Public participation GIS" is a phrase coined to include service learning projects. In these projects, teamwork is developed among student project groups and outside partnerships are forged as students apply project management, communication and critical thinking skills to the task. Many of these projects bring recognition to the students and their school.

### **GIS Program at Clark Magnet High School**

When integrated into the curriculum, GIS shows students the relevant applications of education in career settings. The GIS program at Clark Magnet High School is fully integrated with CTE through the Los Angeles County Regional Occupation Program. All three GIS courses offered at CMHS, Marine Science Research, (AKA Robotics GIS), Environmental GIS and Geology of Disasters, have been adopted and funded by the LA County ROP. Each of these courses is infused with relative career skills that translate across disciplines.

Marine Science Research is a course that teaches basic GIS skills through student self-directed learning using "*Getting to Know ArcGIS*," an Esri Publication. To fill enrollment in a class with little or no subject recognition, marine science is used as the enticement. Marine life studies appeals to a wide range of students, so identification of local marine life and local marine ecology are incorporated into the class. This course also provides an overview into other technology and engineering electives offered at the school.

Students are introduced to computer-aided design and drafting (CADD) with a Google Sketchup assignment to design a remotely operated vehicle (ROV). They experience a taste of the Introduction to Engineering class by building their ROV Sketchup design and competing with other students to collect simulated marine life samples from a pool. Students also learn to use global positioning systems (GPS) with Trimble hand-held Juno receivers through geocaching exercises to find a cache hidden on campus.

After students master the basic skills of GPS and GIS, they are taken into the field to collect marine life data either through participating in snorkel surveys, working closely with scientific divers, or by operating a VideoRay Pro 4 ROV. Through these processes students learn the importance of the spatial component of data collection. Each study area is documented with the GPS coordinates for later input into ArcGIS. Diver and ROV transects are logged by heading and by distance as determined by a laser range finder.

Once back at school, students upload survey data to the Reef Environmental Education Foundation (REEF) online database. Data from REEF and the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) are analyzed in ArcGIS to determine the distribution and abundance of local marine species. Variables such as sea surface temperature, kelp cover and marine protected areas are mapped and examined to illuminate geospatial relationships. In this project, students work side-by-side with industry professionals from The Bureau of Ocean Energy Management, Regulation and Enforcement, Ventura County Sheriff's Search and Rescue Dive Team, National Oceanic and Atmospheric Administration (NOAA) and REEF divers. Although the primary focus is on marine science, the course isn't limited to just the marine environment. Mapping invasive terrestrial plant species has been a focus for many years as well. Generally, a scientific topic will be introduced to the class for all to take part in data collection and analysis. Past projects have included analysis of heavy metals in the sediments of the Los Angeles Harbor, bioaccumulation of contaminants in lobster tail tissues, the effect of marine protected areas on marine species and studying the environmental and health risks from illegal "marijuana grows," which is a new class project.

Environmental GIS is a course that offers students the opportunity to expand their abilities to do research using GIS. This course picks up where Marine Science Research leaves off and challenges

students to either continue developing the project introduced the previous year, or to take on an original investigation of an environmental issue. In both courses, students write a scientific paper on their research and submit abstracts for publication. They also create scientifically formatted posters using graphs made in Excel and a layout designed with Photoshop. They are encouraged to present these posters to the public and the scientific community at symposiums. Clark students regularly participate in the research symposium at California State University, Northridge. Other symposiums have included GIS Day presentations at the Los Angeles County Department of Public Works, Occidental College, the Western Society of Naturalists Annual Meeting and the Southern California Coastal Water Resource Program, where a Clark alumna was given the award for best platform presentation.

The most recent GIS course added to the Clark Magnet program, *The Geology of Disasters; a Hazus-MH Training Course*, is a Career Technical Education course integrating Earth Science standards with Environmental and Natural Science Engineering pathway standards. This course was developed to fit the University of California model for adoption as a “g” (college preparatory CTE) science elective. It is team-taught, with one teacher credentialed in Geology, the other a FEMA certified Hazus-MH Practitioner. In this class, the teaching of the fundamentals of GIS leads up to advanced instruction using FEMA’s Hazus-MH software for risk assessment, loss estimation and loss mitigation strategies for earthquake, flood or hurricane wind hazards. The geologic processes and features relating to these hazards are covered as part of the core academic standards, with an emphasis on the role geography plays in disasters. The Geology of Disasters course appeals to the Jekyll-and-Hyde mentality of the typical teenager. On one hand, they are fascinated with destruction, while on the other hand, they are enthusiastic about helping their community. This course satisfies both those interests while teaching them valuable career skills.

Student teams can enter scientifically based GIS projects into competitions, adding an extra level of motivation. Since 2007, Clark Magnet High School students have won more than \$145,000 in prize money for scholarships and grants from the Lexus Eco Challenge. The success of the Clark Magnet GIS program was highlighted in the 2011 Esri International Users Conference when teacher Dominique Evans-Bye and student Yeprem Chavdarian were invited to speak in the plenary session to showcase how GIS and CTE fit into the school environment. Directly following the Esri conference presentation, Evans-Bye

worked with Glendale officials to implement a GIS student internship with the city. Three Clark students entered this pilot program in 2011, and the quality of their work so impressed the city that an expanded, formalized program will be instituted for 2012. Some of the projects the students worked on included using GIS to update City bus transportation routes, and mapping the location of municipal features such as parking meters and water towers within the city. This thesis will document how the GIS program at Clark Magnet High School was formed, how students have benefitted from it and how it could be improved to include more students.

## CHAPTER 2: METHODS

My thesis has two critical components, development and implementation of high school GIS curriculum at Clark Magnet High School in La Crescenta, California, and assessment of the program. As such, this section will provide an overview of these methodological components of my thesis. The first section will review curriculum development and implementation; the second section will review the process I used to assess the success and impact of the developed program.

### **Development and Implementation**

“The EAST model of education features student-driven service projects accomplished with the latest technology,” EAST Inc. (Environmental and Spatial Technologies). This EAST Initiative introduced Clark Magnet High School to the hardware and software for both geographic information science (GIS) and global positioning systems (GPS) hardware and software. The technology EAST offered was a good fit with the science, technology, engineering and math focus of Clark Magnet High School. In 2003, the school was awarded a grant from the California Department of Education to implement an EAST lab for classes on campus. This grant provided startup money to fully equip the lab and train “facilitators” to run the program. Once the lab was in place, the first EAST class was conducted in the 2003-2004 school year.

EAST has a very different approach to learning. In this course, students choose projects to work on that benefit the environment or their community, and use technology tools to aid their endeavors. Students are in charge of what they learn and the pace at which they proceed. There are no teacher-directed lectures, homework assignments or tests. Proponents of EAST believe that through this process, students are better-prepared for both college and career development, and place greater value on learning and serving their communities. Clark Magnet instructors saw limited success employing the EAST model of education. The class was driven by a few highly motivated students, while the majority of the students did not participate appropriately. Grading was viewed as subjective and easily challenged. This model was abandoned in favor of a more structured approach with well-defined grading rubrics.



## **Marine Science Research**

In an effort to attract a broader range of students to the program, it was decided to offer a project-based GIS course focused on community and environmental issues outside of the EAST program. The first step in designing the new course was to check for existing course outlines that had similar characteristics in the curriculum. In the Glendale Unified School District (GUSD), a “Science Research” course existed that involved using appropriate technology for project-based learning and using mentors from industry that specialized in an aspect of the project. Teaching GIS through the district-adopted Science Research class provided a course catalog number for the records and an established course outline on which to base lesson plans. I made only minor modifications to the previously approved course. The title “Marine Science Research” was informally adopted to promote the new class.

A secondary focus of the modified Science Research class, involved the use of an underwater remotely operated vehicle (ROV) for data collection. Since students design and build their own models and are trained to use a professional ROV in the field, this course also fulfills the student outcomes of the Robotics course in the Los Angeles County Regional Occupation Program (ROP). As the designated instructor, I was well qualified in ROV operations from years of volunteer experience with the Ventura County Sheriff’s Search and Rescue Dive Team. Since I hold a certification as an ROV operator from VideoRay, an ROP teaching certificate was approved by the County. As a result, funding for field trips and equipment became available through LA County ROP. When the three-year advisory committee review period was held, a new module on the fundamentals of GIS was added to the Robotics course outline with the following description:

### **Introduction to Geographic Information Systems (GIS) Module:**

“Students will run surveys and search patterns using a remotely operated vehicle. Students will map the search/survey areas covered by the ROV. Data collected by the ROV during operations will be analyzed by students. ArcGIS software will be introduced in this class to facilitate mapping and analysis projects involving the ROV. Basic fundamentals of GIS will be mastered and a solid foundation for higher level GIS courses will be built.”

From this it was determined that students taking the Marine Science Research class would be eligible for dual credit in ROP Robotics.

### **Environmental GIS**

The success of the Marine Science Research class was limited in that it was only a one-year science elective course. Students could enroll a second time, but would not get credit for a second course. This left few students returning for advanced instruction. When a single student enrolled, there was little motivation to work on solo projects, so that student would act as teaching assistant, helping others through basic GIS skills. There was a positive side to this approach, as learning through teaching is a strong reinforcement of skills and benefits the young “teacher” as much as the new student. However, when a group of students took the research course a second time, the students made great accomplishments through project-based learning.

In order to provide advanced instruction in GIS and increase enrollment for a project-based learning class, a new course needed to be offered. Following the steps taken to offer Marine Science Research, again the district course catalog was examined. To create a new course, the existing Environmental Science course was combined with Science Research to produce a course that was project-based, technology-driven and focused on researching environmental issues.

Writing the course outline mainly involved reformatting existing curriculum. Using this simple technique, the Environmental GIS class was created. For Environmental GIS to be formally adopted by the district, standard course-approval operating procedures had to be met. The finished course outline was presented at the district Curriculum Study Committee (CSC) meeting. The proposed textbook was introduced, and review cards distributed to volunteer reviewers. One teacher from each of the high schools in the district was required to review the primary textbook for the proposed course. The course was then approved for adoption by voting CSC members from each GUSD high school. After approval, the course was voted on at a district Principals’ meeting. The final step was the formal approval from the school board to include the course in the district catalog. The entire GUSD approved outline for Environmental GIS can be found in appendix A.

After district approval was met, the goal was for the LA County ROP to recognize Environmental GIS as a valid career technical education (CTE) topic. An existing ROP outline was used as a template for the EnvGIS course, as the outline format required by the LA County ROP is completely different from the format required by the GUSD. With GIS being a new topic to ROP, most of the content relating to instruction had to be created. As part of the program, all ROP courses are matched to one of fifteen *Industry Sectors* and then to a specific *Pathway* within the sector. After careful review, the best fit for GIS courses at Clark Magnet High School fell within the “Engineering and Design” Industry Sector, and the “Environment and Natural Science Engineering” Pathway.

The next step was to conduct a labor market review using the Occupational Information Network (O\*NET) website to find Standard Occupational Classification crosswalk codes for applicable job titles within the industry addressed in the class. This was followed by a labor market analysis to determine job projections in the field. A promising labor market outlook gave the green light for the course to be developed. In compliance with ROP guidelines, the course outline links instructional content to student outcomes. Each outcome was connected to one or more of the Foundation and Pathway standards from the Industry Sector. A mandatory advisory committee from the industry was formed to meet and review the new ROP course outline. After receiving input from committee members, course revisions were made accordingly. Advisory committee meetings are required every three years to ensure the course is up to current industry standards and meets the need of providing properly trained personnel for the workforce. The Environmental GIS ROP outline was created with modules on:

- Career Essentials
- Project management
- Research Design
- Data Collection
- GIS Applications and Analysis
- Communicating Results

These modules will be detailed in the Results section of this Thesis. The entire approved ROP outline can be found in appendix D. The lesson plans for the course are taken from contest rules and judging criteria of

current science competitions, and modified to incorporate ROP Foundation and Pathway standards. The Lexus Eco Challenge has an “Action Plan,” for a “Land/Water” challenge and an “Air/Climate” challenge, each with a format for students to follow. The USC “QuikScience Challenge,” has a different set of activities and format that must be adhered to. Siemens, Google, Thacher and Los Angeles County Science Fair also promote student research competitions in which Clark students have participated.

### **The Geology of Disasters; a Hazards US, Multi-Hazards (Hazus-MH) Training Course**

The development of an additional GIS course, The “Geology of Disasters,” was a project funded and supported by a University of California, Los Angeles *Teacher Initiated Inquiry Project* (TIIP) grant. The TIIP grant required that a team of teachers work together to choose their own professional development in order to implement a new program or effective teaching strategy for students. Clark’s proposal was one of twenty-three selected from the hundreds submitted for the TIIP grant.

The awarded Geology of Disasters TIIP proposal brought a team of teachers and the head counselor together to work on developing a new science elective course. To implement the development of this new course, one instructor, Dominique Evans-Bye, completed five FEMA Hazus-MH courses to earn a Hazus-MH Practitioner certification. The other instructor, Alex Day-Blattner, supplemented her physical science background by taking additional college courses in weather systems and physical geology, earning an additional California Teaching Credential in Earth Science. The advanced industry training from FEMA qualified the course to be considered for ROP. Geology of Disasters was designed from the beginning as a career technical education (CTE) integrated course in order to be eligible for University of California approval as a category “g” high school science elective.

Beginning at the district level, the current Geology course outline based off California State Earth Science standards was reviewed to find matching course content with the Environmental and Natural Science Engineering Industry Sector CTE Pathway standards. This existing Geology course outline was modified to emphasize geologic features and processes related to natural disasters. The FEMA program manager for Hazus-MH gave his approval to develop the Geology of Disasters course using FEMA educational materials and Hazus-MH course outlines. These outlines were merged to create an academically rigorous course that met student outcomes in both CTE and California State science

standards. Topics covered through the newly developed outline for the GUSD connected the California Earth Science and Investigation and Experimentation standards to FEMA and academic content covered in the course. This course has been approved by the GUSD (appendices B and C) and LA County ROP as two, one-semester classes: Geology of Disasters “A” and “B.” The ROP outline for this course was created with the following modules:

1. Career Essentials
2. Intro to GIS
3. Intro to Hazus-MH
4. Intro to Earthquake Analysis
5. Intro to Flood Analysis
6. Intro to Hurricane Analysis
7. Group Exercise
8. California, West Coast, Pacific Rim
9. Weather
10. Oceans and Climate Change

These modules were adapted into a University of California (UC) CTE integrated outline (appendix E). The lesson plans for the CTE portion of the course are taken from FEMA educational materials with permission.

To produce a UC CTE integrated outline for approval as a “g” science elective, two Clark Magnet High School instructors attended the UC Curriculum Integration Institute at the Lake Arrowhead Resort, May 1-4, 2011. The offering of this four-day fully funded institute underscores the importance the UC system places on integrating CTE into the curriculum. The training on course creation helped motivate and empower educators and administrators in developing new courses to meet updated guidelines for the “a-g” requirements. The techniques learned at this institute were employed in creating the outline of the Geology of Disasters for UC submission. To begin the process, an online application found on the UC Doorways portal was completed with each of the following sections addressed:

1. Course description

2. Background information
3. History of course development
4. Textbook/supplemental materials
5. Course purpose/course goals
6. Course outline
  - a. Student outcomes
  - b. Academic standards topics
  - c. CTE standards topics
  - d. Laboratory activities
  - e. Key assignments
  - f. Instructional methods and/or strategies
  - g. Assessments

The procedures used to create district, ROP and UC accredited GIS courses can be used by any teacher or administrator to develop or expand a GIS program at the secondary school level.

### **Assessment**

An analysis of California Standard Test (CST) scores from Clark Magnet High School students was conducted comparing the performance of GIS students to that of students at Clark Magnet who had not taken a GIS course. The comparison was done using cohort groups of students enrolled at Clark for each year that a GIS course was offered. The time frame for this study spans the 2006-2011 school years. A line/column graph on two axes was used to illustrate scaled science scores from CST tests in comparison to the Investigation/Experimentation cluster of the CST. This cluster is the only component consistently tested for in all CST science assessments. For each year GIS was offered, student scores were compared in the year prior to taking a GIS class, during enrollment in a GIS class and the year following the GIS class.

All ninth grade students entering Clark Magnet enroll in Conceptual Physics, and are required to take the Physics CST in the spring of their freshman year. With few exceptions, sophomore students enroll in Biology and take the Biology CST, while juniors enroll in Chemistry and take the Chemistry CST. Seniors are not tested. As cohort groups progress through the before-during-after analysis sequence, the

total number of students tested in the group drops, since the junior year is the last year student are assessed by the CST. To further illustrate before-during-after results, Investigation/Experimentation cluster data was displayed as a stacked column graph color-coded by the performance categories:

- Advanced
- Proficient
- Basic
- Below Basic
- Far Below Basic

Advanced and Proficient are the target levels for student performance. To give another perspective of the analysis, Advanced and Proficient groups were combined into one category and compared to a second category combining scores that need improvement; Basic, Below Basic and Far Below Basic. A percent improvement graph was constructed by calculating the difference between the Advanced and Proficient group prior to a GIS class and either after or during a GIS class, depending on the availability of data. Non-GIS student performance was measured in the same fashion with results displayed side-by-side in a column graph.

## CHAPTER 3: RESULTS

The instruction and ideas I've received through the graduate program at California State University, Northridge has enabled me to develop three unique GIS courses for Clark Magnet High School:

1. Marine Science Research (A.K.A. Robotics GIS)
2. Environmental GIS
3. Geology of Disasters

A course outline developed for the new Environmental GIS course and a course outline created for the Geology of Disasters course were adopted by the Glendale Unified School District. Separate outlines for different format requirements were respectively adopted by the LA County ROP for each new course. In addition, a career technical education (CTE) integrated course outline for the Geology of Disasters was designed as a "g" science elective course and has been approved by the University of California Office of the President. The officially adopted outlines for these courses are included in appendices A-E.

Details of each of these courses and their impact on student success will be reported in this section. An analysis student standardized test scores will be included. With only a few exceptions, assessment results apply strictly to students in the Marine Science Research class. Environmental GIS was not introduced until the 2010-2011 school year, with an enrollment of three juniors and two seniors. Senior students do not take the mandated standardized exams. Environmental GIS has been taught the past two years as a split class, with a section inside a Marine Science Research class. Geology of Disasters is slated to be offered for the first time in the 2012-2013 school year. Select lesson plans for the Geology of Disasters have been piloted in the Environmental GIS course with great success. Upon the recommendation of FEMA, my students and I have been recruited by Glendale City officials to update the required hazards plan for the city using Hazus-MH analyses.

### **Marine Science Research (A.K.A. Robotics GIS)**

The first true GIS course offered at Clark Magnet High School was informally called; "Marine Science Research." To create this course, the existing Science Research course curriculum was repurposed with a focus on analyzing marine-related issues with a remotely operated vehicle (ROV) and GIS. The



emphasis of ROV technology applications qualified the course to be listed in the robotics category of the Los Angeles County Regional Occupation Program (ROP). The existing ROP Robotics course outline was modified to incorporate a GIS module into the curriculum. Students enrolled in the Marine Science Research class at Clark Magnet High School are dually enrolled in ROP Robotics/GIS.

The resulting course exemplifies a balance between a no-pressure, fun class and the challenge of learning a new skill. On average, approximately seventy-five percent of students apply themselves in class and appreciate the opportunity the class provides. Approximately twenty-five percent of students lack the motivation to problem-solve and challenge themselves with higher level thinking skills, but most perform at a passing level. Students who I would consider to be average have done exceptionally well in pursuing outside opportunities, such as the GIS internship with the City of Glendale. One such student now holds an official job in the City Planning Department.

### **Environmental GIS**

Students' basic GIS skills are reinforced in this class, and expanded by investigating advanced geoprocessing tools and extensions to meet the objectives of a chosen project. ROP modules are not taught sequentially, but interspersed throughout the course. Major learning components are described below:

1. **Project Management:** Students will use MS Project to define team member's roles and responsibilities, create project timeline, oversee team progress through Gantt charts, work break-down structures and ensure project delivery meets submission guidelines.
2. **Research Development:** Students will gather background information related to their field of investigation through a scientific literature search. Students will critically analyze the format of scientific papers and be able to properly cite sources when presenting findings. Students will develop their own research question to be investigated. They will form a hypothesis to be tested through scientific study. They will design a study to test their hypothesis following scientific guidelines.
3. **Data Collection:** Students will use publicly available remote sensing data and/or field collected data from hand held GPS, ROVs, sonar or other sources.

4. GIS Applications and Analysis: Students will create models and use appropriate geoprocesses to investigate issues within their community and environment.
5. Communicate Results: Students will write a scientific paper meeting guidelines for publication. Students will use Photoshop to create scientifically formatted posters.

Research findings will be presented in PowerPoint presentations and poster symposiums.

As students take part in developing and implementing their own research projects, their confidence and abilities grow. These characteristics have been observed in all the advanced level GIS students, regardless of whether or not they win project competitions.

### **Geology of Disasters; a Hazus-MH Training Course**

In the Geology of Disasters, students will participate in one semester focused on academic instruction in geology, the other emphasizing instruction on GIS software. The course will be team taught, with the student roster rotated between instructors at the end of the first semester. Academic instruction will emphasize geologic processes in relation to natural disasters. The two semesters parallel one another in content area and complement each other in instructional methods. A traditional classroom setting will be used for the academic portion of the course, while a computer lab will be the primary classroom for software instruction. Modules were created for this course and approved by an industry advisory committee to meet ROP guidelines. All Academic modules meet California State Science Curriculum Standards for Earth Science.

UC “a-g” format requirements are exemplified in the Geology of Disasters approved outline shown in appendix E. The course outline was created collaboratively between the academic instructor and the CTE instructor.

The Glendale Unified School District course outline for the Geology of Disasters was split into two separate outlines, GOD “A” and GOD “B.” Sections “A” and “B” will be run simultaneously, with the “A” course consisting of the odd-numbered modules listed above focusing on academic standards, while the “B” course will consist of the even numbered modules and focus on teaching the Hazus-MH, GIS portion of the course for CTE. At the end of the semester, students will swap sections to complete the year-long course. Section “A” is not a prerequisite for section “B.” It will make no difference in the order that

the courses are taken. Classes will be combined for field studies. The approved GUSD outlines are in appendices B and C. The UC “g” elective course outline is in appendix E. LACOE is currently formatting the ROP outline for the Geology of Disasters for publication.

### **Partnerships**

A very important attribute of the new GIS courses is the partnerships that have been forged or strengthened while creating the courses. Table one details current partners with the Clark Magnet GIS program and the role they play in the partnership.

Table 1.

	Communication Platform	Equipment / Software	Data	Funding	Internships	Mentoring	Volunteers
BOEMRE			X				X
CA Science Center							X
Coastal Marine Biolabs		X	X			X	
CSUN	X			X		X	X
Esri	X	X	X			X	
Explorer Dive Boat		X	X				
FEMA	X	X	X	X		X	
GCC/PCC		X		X			
Glendale City GIS					X		
IIRMES		X	X			X	
LA City Fire							X
LA Co. GIS	X		X				X
LA Co. ROP		X		X			
Lexus	X	X		X			
NOAA		X	X			X	X
PISCO/WSN	X		X				
REEF			X				
Santa Monica Seafood Company			X				
Society for Science and Public		X		X		X	
Sport Chalet		X					X
Trimble		X				X	
UCLA	X			X			
USC	X					X	
Ventura County Sheriff's		X	X				X
Verdugo Fire Communications			X				X

The partnerships above have proven to be an invaluable asset for student success. The resources provided by CMHS partners have enabled students to excel in project competitions dealing with community and environmental issues. The most notable examples of these successes include a team of six students winning the 2007 Lexus Environmental Challenge Water Challenge for the Western region. For this project, the students did a spatial analysis of heavy metals in the Los Angeles Harbor sediments. The maps were shared with public safety dive teams that work in the harbor and could be exposed to the contaminants. In 2008 a team of five students won First Place in the Lexus Environmental Challenge Final Challenge for working to document the effect of marine protected areas on marine life in the Channel Islands National Marine Sanctuary. In 2010 a team of five students won the Lexus Eco Challenge for the Land/Water division for the Western region. These students documented organic and inorganic

contamination in lobster off the coast of Southern California by testing tail tissues at the Institute for Integrated Research in Materials, Environments, and Society, then classifying a weighted average of contamination by lobster size in ArcMap. The same team of students won the 2010 Lexus Eco Challenge Air/Climate division for their region by using Hazus-MH to assess the flood risk to schools within the GUSD. These students later went on to win the 2011 Lexus Eco Challenge Final Challenge Grand Prize for taking the lobster contamination project to a global level and mapping contamination in lobster tails from East Canada, Western Australia, South Africa and Nicaragua.

Students used Hazus-MH to generate a stream network and mapped storm drains with outflow to the ocean in order to show how pollution makes its way from the land to the sea in 2011 Generation Earth “Streets to Sea” Challenge. This project connected the earlier Hazus-MH flood project with the contamination of local lobster off our coast. The team was selected as a finalist and showcased their project at Disney Studios in Burbank. Esri chose to feature the Clark Magnet GIS program highlighting these projects in the 2011 plenary session.

Six GIS students brought their own research projects to the 2011 Western Society of Naturalists Annual Meeting in Washington State and participated in the poster symposium. The scores that students earned from WSN judges for their presentations fell into the “met expectations” or “exceeded expectations” for every category in the WSN rubric. The 2011-2012 school year brought more success in the Lexus Eco Challenge with students taking a regional win in the Air/Climate Challenge and then on to a first place win with a spatial analysis project on ozone smog pollution. To date, students have won \$145,000 in grants and scholarships from Lexus. Facilitating student research in high level GIS projects resulted in teacher awards and funding. A portion of each of the Lexus Eco Challenge awards went to the teacher for classroom related projects and a portion went directly to the school. A UCLA “Teacher Initiated Inquiry Project” grant provided \$30,000 for professional development and a Society for Science and the Public Fellowship have funded materials and activities related to student research project for four years with an annual stipend of \$8,500.

### **Assessment**

In the 2007-2008 school year, twenty-one sophomore/junior and eleven senior students were enrolled in GIS class at Clark Magnet High School. Examination of California State Test (CST) scores

found a four-percent increase in average CST scores of GIS students in the Investigation/Experimentation cluster over a three-percent increase seen in other Clark cohort students. Mean scaled science scores increased eight points for GIS students while a decrease of five points was observed for the non-GIS students over the same time period. Test scores for seniors are only available for the year prior to taking the GIS class. No GIS students from this cohort were tested in the 2008-2009 school year (Figure 1).

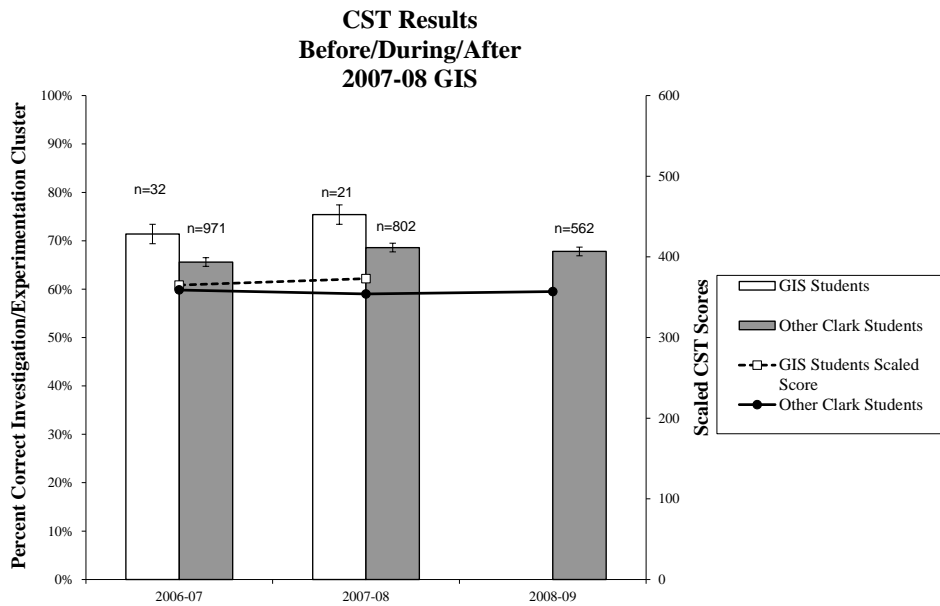


Figure 1. 2007-2008 cohort groups showing CST scores for GIS versus non-GIS students.

A stacked bar graph of test result categories for the Investigation/Experimentation cluster illustrated a shift towards Advanced and Proficient status for students enrolled in a GIS course versus those who were not enrolled in a GIS course in the 2007-2008 school year (Figure 2).

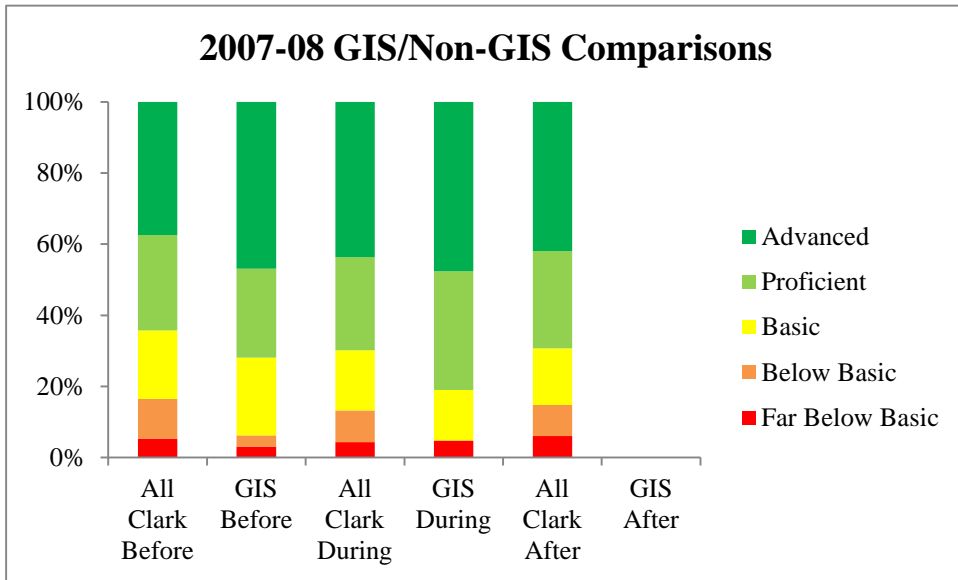


Figure 2. Stacked bar graph illustrating the proficiency levels of 2007-2008 cohort students.

Advanced and Proficient are the categories targeted by educators as the goal students should attain. The 2007-2008 GIS/Non-GIS Target Categories graph separates the Advanced and Proficient categories from the categories needing improvement, Basic, Below Basic and Far Below Basic to better show progress over time (Figure 3). An analysis in the percent difference between these categories show a 9.1 percent improvement in the Investigation/Experimentation cluster CST scores for GIS students and a 5.5 percent decline in performance for that category in non-GIS students at Clark during the 2007-2008 school year (Figure 4).

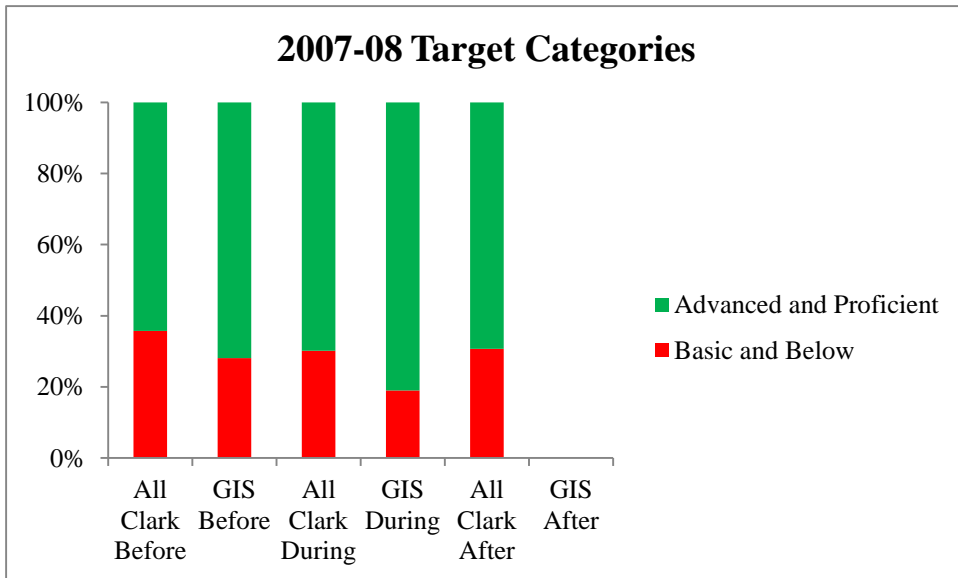


Figure 3. Target category levels for GIS versus non-GIS students in the 2007-2008 cohort group.

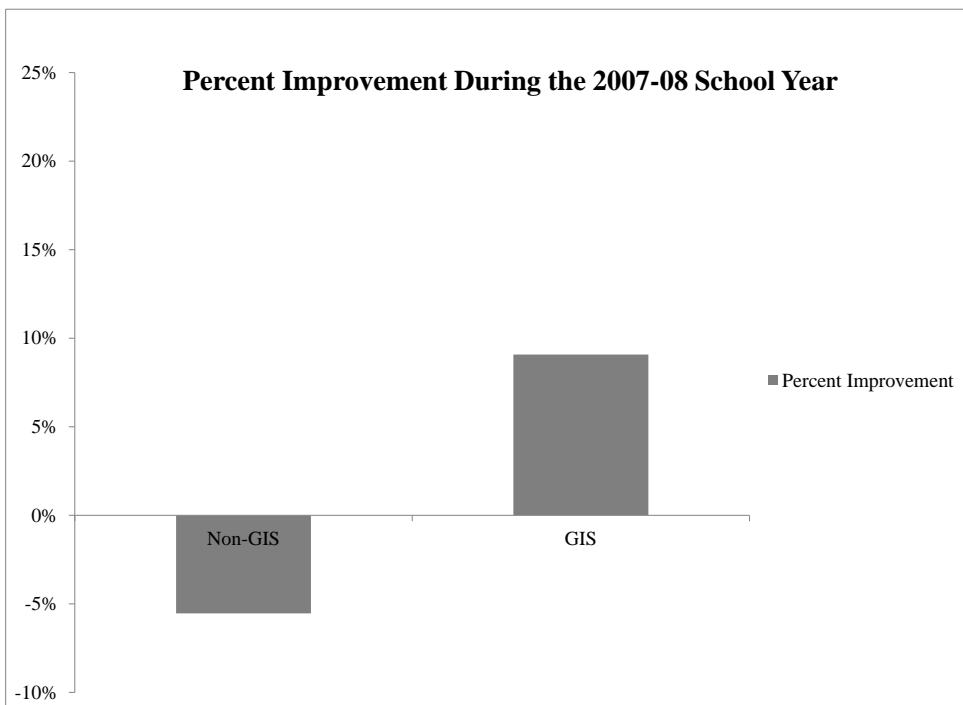


Figure 4. GIS students show a greater percentage of CST scores increasing to the Proficient and Advanced categories over non-GIS students in the 2007-2008 cohort group.



In the 2008-2009 school year, sixty-three junior students were enrolled in GIS class at Clark Magnet High School. CST scores found a 6.2 percent decrease in average CST scores of GIS students in the Investigation/Experimentation cluster compared to a 3.5 percent decrease seen in other Clark cohort students. Mean scaled science scores dropped 23.7 points for GIS students while a decrease of 15.7 points was observed for the cohort non-GIS students over the same time period. Of the two GIS students who were tested the year after taking GIS instruction, one scored a perfect six on the Investigation/Experimentation cluster, while the other a three. This 50 percent average is in contrast to the 70.4 percent average of the 561 other Clark students in that cohort (Figure 5).

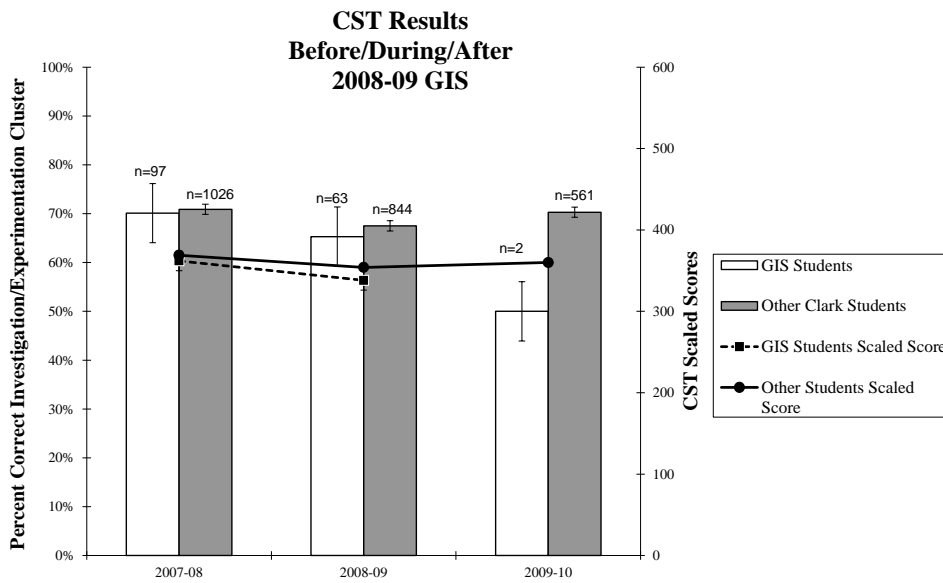


Figure 5. 2008-2009 cohort groups showing CST scores for GIS verses non-GIS students.

A stacked bar graph of test result categories for the Investigation/Experimentation cluster found fewer Advanced level students for both categories, with the percentage of GIS students in the Far Below Basic category doubling, while numbers of non-GIS students decreased as those in the Basic category increased for the 2008-2009 school year (Figure 6).

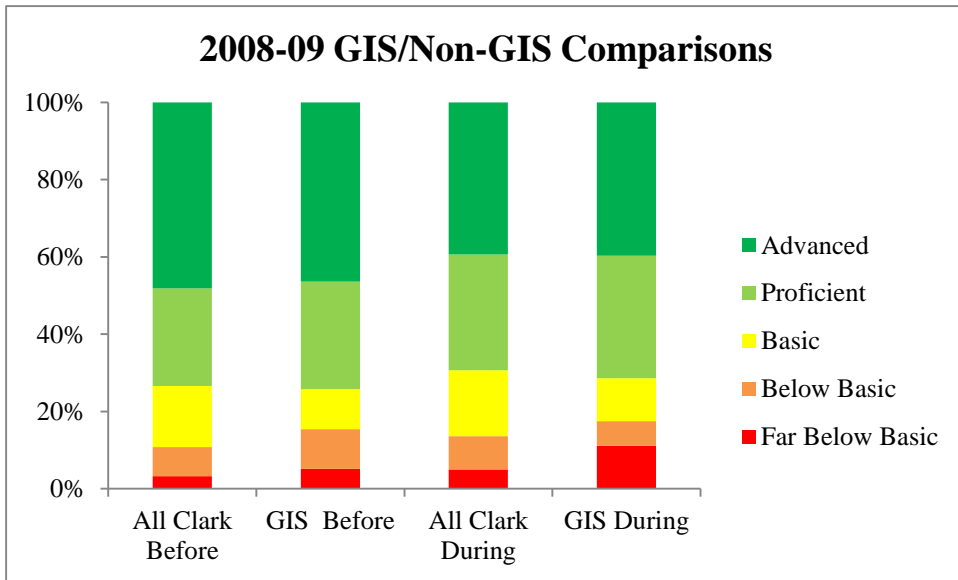


Figure 6. Stacked bar graph illustrating the proficiency levels of 2008-2009 cohort students.

An analysis in the percent difference between Advanced and Proficient categories from the categories needing improvement show a 2.8 percent decline in the Investigation/Experimentation cluster CST scores for GIS students and a 4.1 percent decline in performance for that category in non-GIS students at Clark during the 2008-2009 school year (Figures 7 and 8).

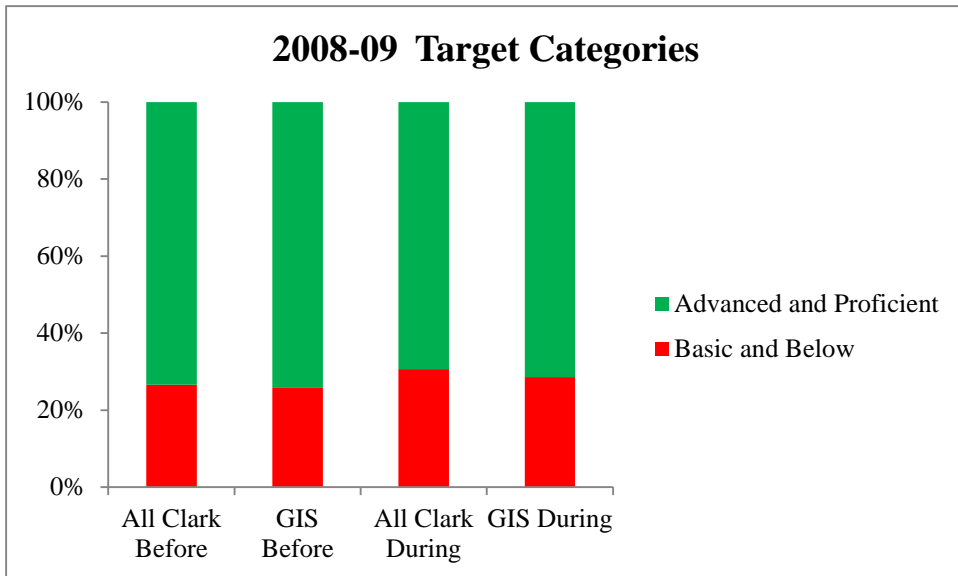


Figure 7. Target category levels for GIS versus non-GIS students in the 2008-2009 cohort group.

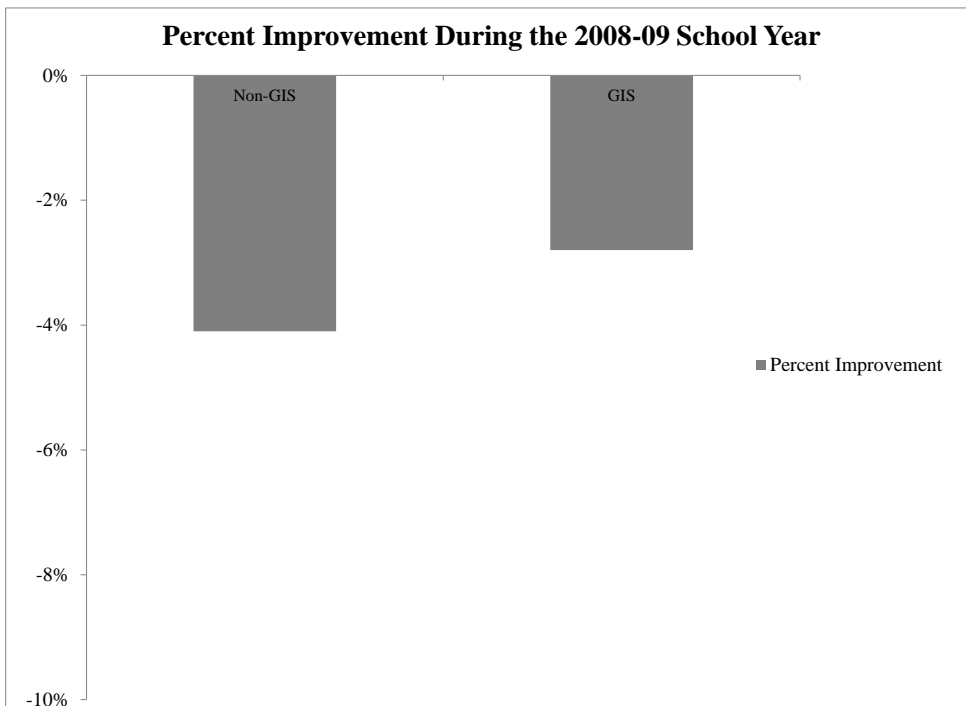


Figure 8. GIS students show a smaller decline of CST scores decreasing to the “Basic” and “Below” categories over non-GIS students in the 2008-2009 cohort group.

In the 2009-2010 school year, thirty-eight sophomore/junior students were enrolled in GIS class at Clark Magnet High School. Examination of California State Test (CST) scores found a 4.2 percent increase in average CST scores of GIS students in the Investigation/Experimentation cluster compared to a 6.4 percent decrease seen in other Clark cohort students (Figure 2). Mean scaled science scores increased 5.4 points for GIS students while a decrease of 12.3 points was observed for the non-GIS students over the same time period. Scores in the Investigation/Experimentation cluster continued to rise at a greater rate than for those students who had not taken GIS. A year later, GIS students averaged 81.7 percent while non-GIS students averaged 76.8 percent. (Figure 9).

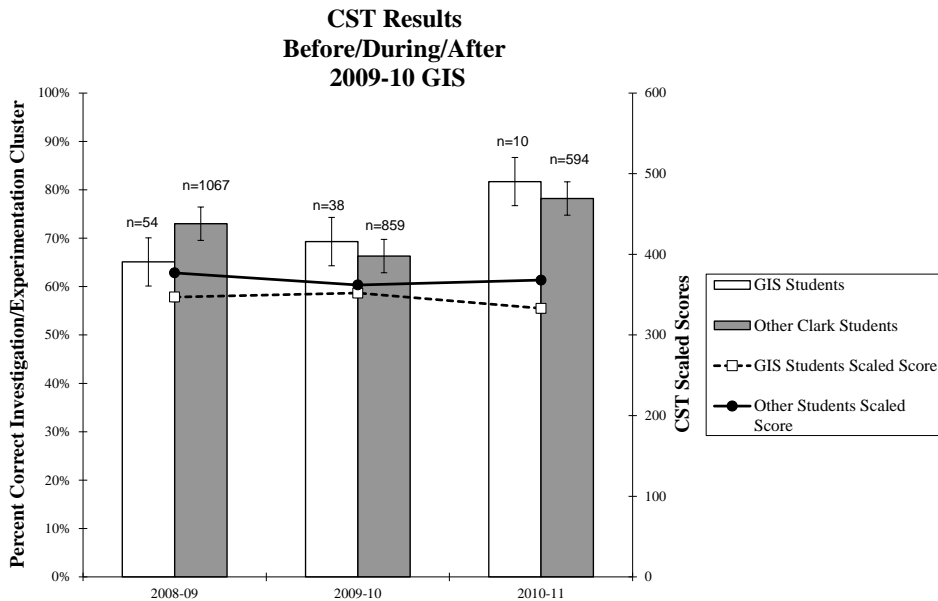


Figure 9. 2009-2010 cohort groups showing CST scores for GIS versus non-GIS students.

A stacked bar graph of test result categories for the Investigation/Experimentation cluster found Advanced scores increased 15.9 percent for GIS students, while they decreased by 12.8 percent for non-GIS students. The percentages of GIS students in all categories below advanced increased for non-GIS students (Figure 10).

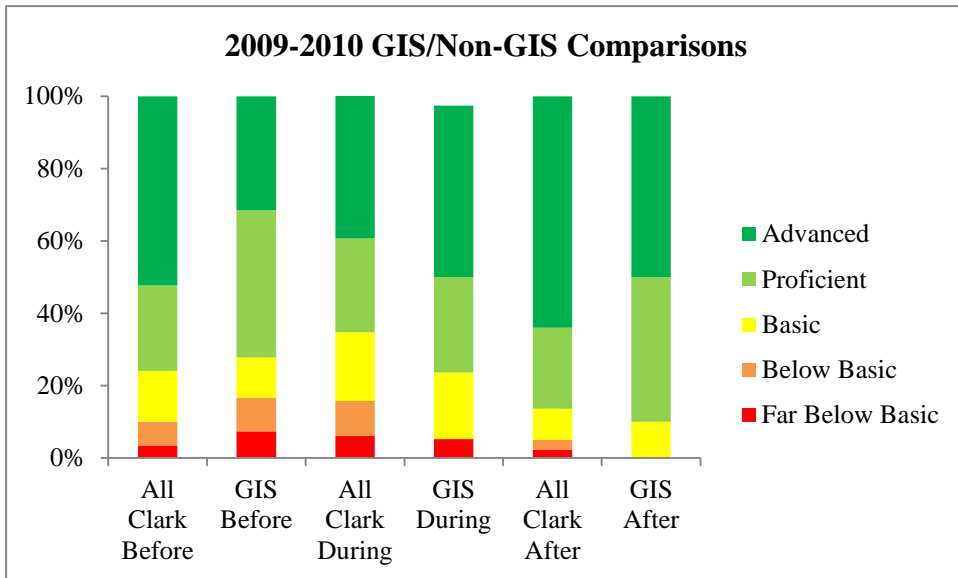


Figure 10. Stacked bar graph illustrating the proficiency levels of 2009-2010 cohort students.

An analysis in the percent difference between Advanced and Proficient categories from the categories needing improvement show a 17.8 percent improvement in the Investigation/Experimentation cluster CST scores for GIS students over a 10.4 percent improvement in performance for that category in non-GIS students at Clark during the 2009-2010 school year (Figures 11 and 15).

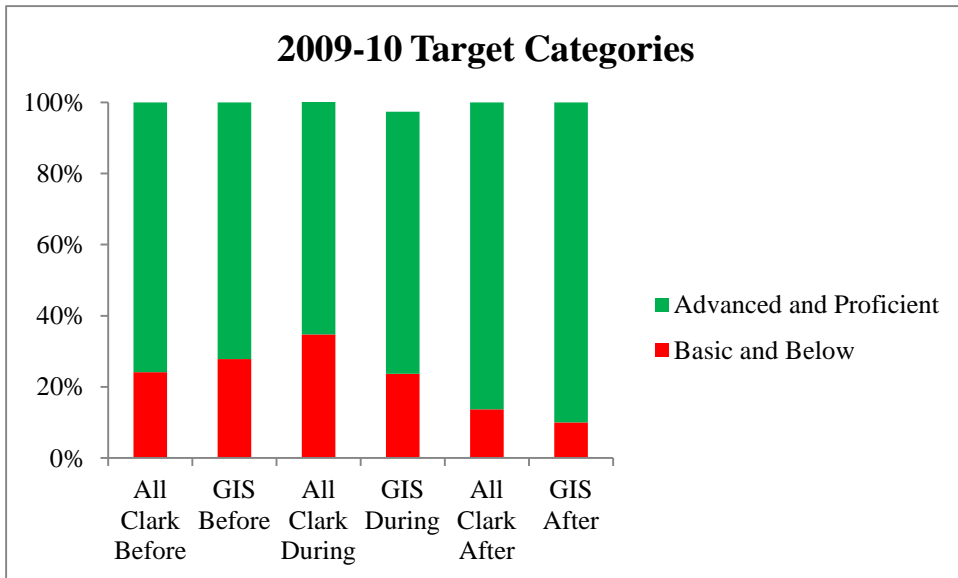


Figure 11. Target category levels for GIS versus non-GIS students in the 2009-2010 cohort group.

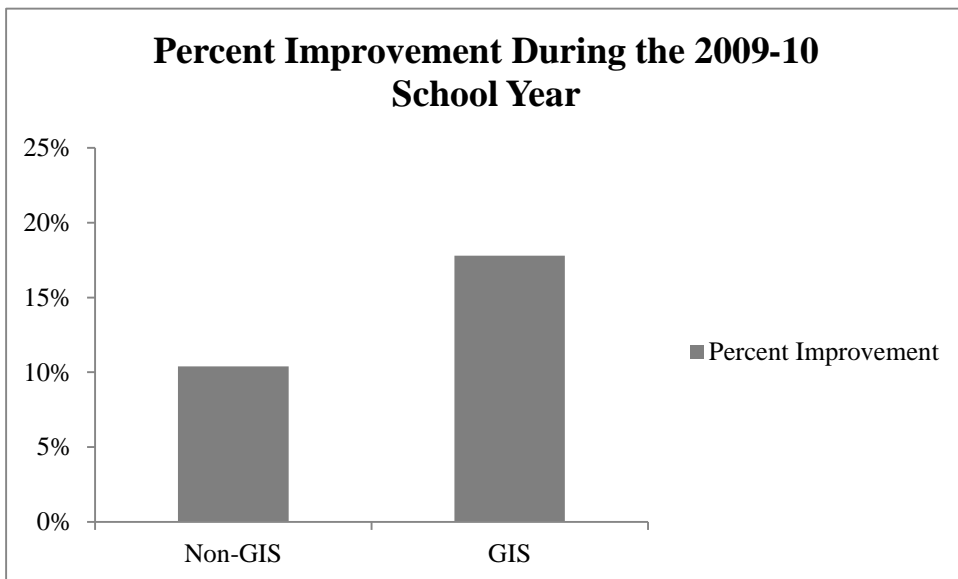


Figure 12. GIS students show a greater percentage of CST scores increasing to the Proficient and Advanced categories over non-GIS students in the 2009-2010 cohort group.

In the 2010-2011 school year, fifty-three sophomore/junior students were enrolled in GIS class at Clark Magnet High School. Examination of CST scores found a 17.9 percent increase in average CST scores of GIS students in the Investigation/Experimentation cluster compared to a 0.7 percent decrease seen in other Clark cohort students (Figure 13). Mean scaled science scores decreased 2.4 points for GIS students while a decrease of 6.9 points was observed for the non-GIS students over the same time period. The 2011-2012 CST have not yet taken place.

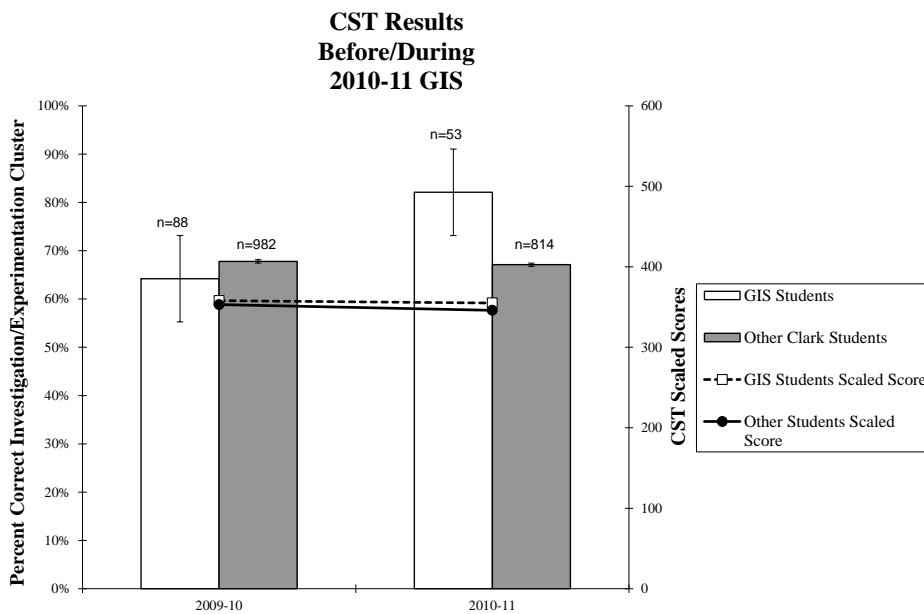


Figure 13. 2010-2011 cohort groups showing CST scores for GIS verses non-GIS students.

A stacked bar graph of test result categories for the Investigation/Experimentation cluster found Advanced scores increased 43.3 percent for GIS students, while they decreased by 3.8 percent for non-GIS students. (Figure 14). Combining target categories for the 2010-2011 school year found GIS students to increase placement in Advanced and Proficient categories by 22.8 percent, while non-GIS student fell from the target range by 2.1 percent (Figures 15 and 16).

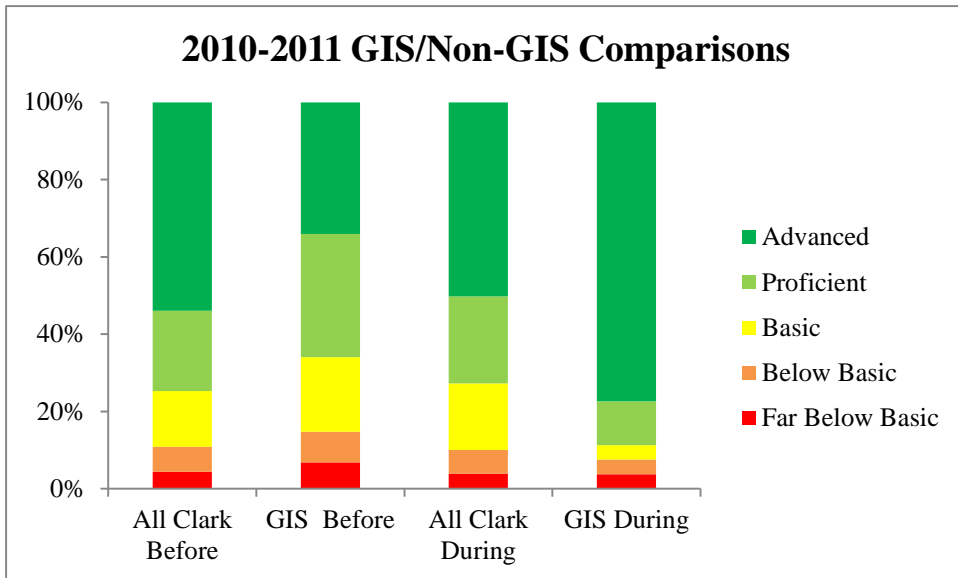


Figure 14. Stacked bar graph illustrating the proficiency levels of 2010-2011 cohort students.

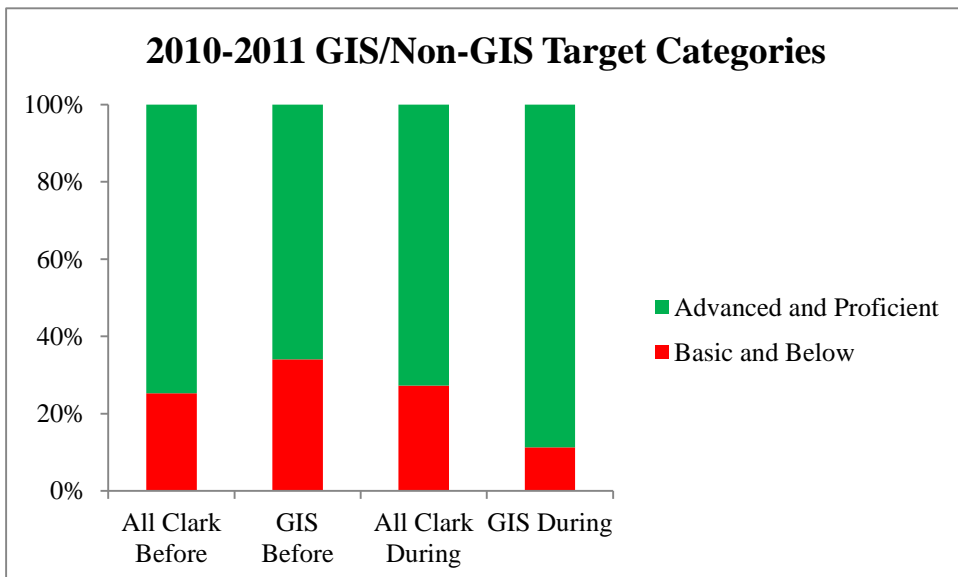


Figure 15. Target category levels for GIS verses non-GIS students in the 2010-2011 cohort group.



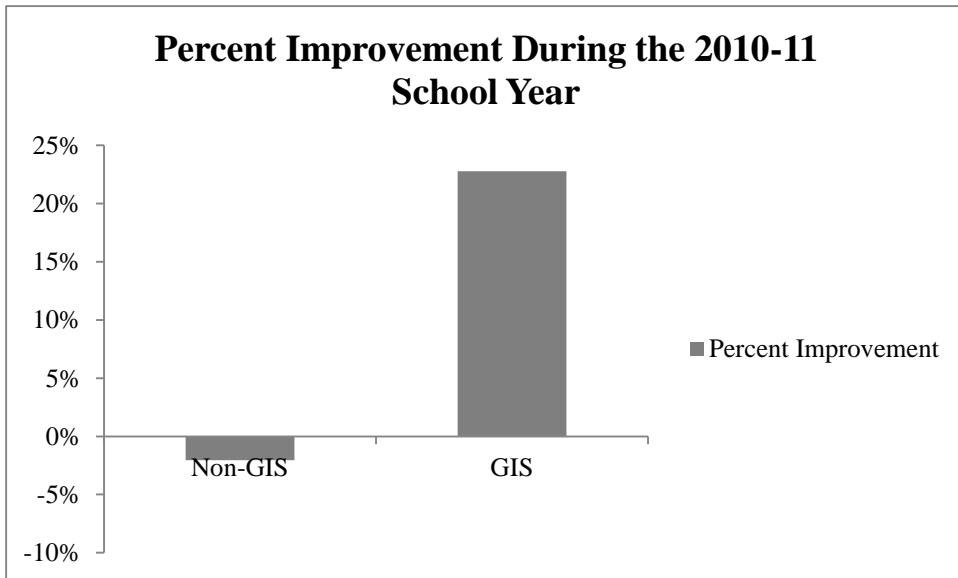


Figure 16. GIS students show a greater percentage of CST scores increasing to the Proficient and Advanced categories over non-GIS students in the 2010-2011 cohort group.

## CHAPTER 4: DISCUSSION / CONCLUSION

The null hypothesis that there is no difference between the test scores of Clark Magnet High School students who have taken a GIS class versus Clark Magnet students who have not taken a GIS class could not be accepted. With the majority of students enrolling in GIS courses as juniors or seniors, data on student performance after GIS instruction is too sparse for valid statistical analysis. Standard error bars on California Standard Tests simply show a larger variation in scores within smaller sample sizes for GIS students. A descriptive analysis of the data suggests that the performance of students who have been trained in GIS at Clark Magnet is on average, higher in the Investigation/Experimentation cluster of the California Standard Test. Data from the 2008-2009 school year does not fit the trend of improving student test scores. The overall decline of scores in the 2008-2009 school year was most likely due to the death of a classmate in a violent car accident just days before testing began. The crisis counselors the district provided could not mitigate the school-wide emotional reaction from grief stricken students which almost certainly affected their test-taking abilities. In the 2009-2010 school year, only two GIS students were sophomores. One of those sophomores was autistic and in the special education program. While one student scored a perfect six on the Investigation/Experimentation cluster, the autistic student scored a three. With a sample size of only two for the "After" category, this skewed results and brought the percent correct down to 50 percent. Two students is not an adequate number to use for comparison against a cohort of 561. These results imply that the GIS students in this cohort greatly declined in their cognitive abilities. This erroneous conclusion should be disregarded.

The most telling data from this analysis comes from the "Percent Improvement" comparisons. In every year observed, GIS students had a higher improvement rate (or smallest rate of decline) for moving students into the target categories of Advanced and Proficient. Scaled science scores did not prove to be an accurate way to assess the impact of GIS on learning. Each year, these scores reflect different science classes and the impact from various teachers. The Investigation/Experimentation cluster is the only consistent indicator across years for the effect the Clark Magnet GIS program has on students' cognitive abilities.

## **Vision and Roadblocks**

It is hoped that GIS will become incorporated throughout the curriculum at Clark Magnet High School. In order for this to occur, other teachers will need to see the benefits GIS instruction offers. As teachers experience success using GIS in the classroom, the practice will be shared and grow among their peers. Eventually, the success will not be limited to Clark Magnet, but shared with other schools and other districts. To achieve this vision, eight potential roadblocks must be circumvented. The roadblocks that will be addressed in this thesis are:

1. computer access
2. software cost
3. installation/licensing/maintenance
4. teacher training
5. instructional time
6. filling enrollment
7. teacher salaries
8. developing new course outlines

The information presented in this thesis will begin to eliminate potential roadblocks to incorporating GIS into the K-12 curriculum.

Computer access: If it is not feasible to have a set of computers for a full-time GIS class, GIS lessons can supplement core academic courses with only part-time computer access. Even if only one computer is available to a class, significant geospatial knowledge and connections can still be imparted to students to make the class relevant, interesting and fun. In the online virtual course, “Teaching with GIS: Introduction to Using GIS in the Classroom,” Esri proposes that a teacher begin a class with a short “GeoNews” segment. This segment would entail a current event discussed in class in a geographic context. Student teams would then take turns investigating current events and leading short class “GeoNews” presentations using ArcGIS Online.

Software cost: The cost for an educational site license for Esri software is merely pennies on the dollar, making it easily affordable. A school site can have unlimited use of ArcGIS for \$500 per school. Nationwide, fifteen statewide license agreements have been implemented. In states not included in those

agreements, forty district licenses have been set up, giving zero-dollar access to thousands of schools. If a school site is not included in a pre-arranged agreement, and the investment in an educational license is beyond budget, a free evaluation version of the software is available from Esri upon request.

Installation/licensing/maintenance: A common roadblock teachers encounter is having the software installed. The software installation process is simple and straightforward by using an integrated installation wizard. A big hurdle teachers face in most school districts is that they do not have administrative privileges that allow them to install software on district computers. Many districts have a centralized technology department that is tasked with servicing the entire district. Non-standard software installations are viewed as time consuming and non-essential. Requests for GIS software installation are given a low priority compared to the daily responsibilities of the technology department. (Anonymous, personal communication) The best way for GIS software to be installed and maintained at a school site is to build professional relationships with both the administration and the technology department. It is important to have strong support from the school's administration. It is very helpful to have the support of the school district and school board. For best results, a relationship needs to be built with the technology department employees who will actually be installing the software. In the beginning, it may even take personal visits to the department to assist with the installation process. For example, one technology expert reported that he was given the wrong software and could not proceed with the installation. The problem was that during the installation process, the directions called for installing ArcGIS, but the program wizard displayed an icon for ArcDesktop. Meeting face-to-face can avoid this type of confusion, and builds the communication needed to get the job done. ArcGIS can be installed on individual computers or installed as an image over a network of computers. A server can be set up for a district, a school site or a single classroom. There is also an option to run an ArcGIS server on an Amazon cloud. The variety of strategies for installation and implementation are designed to fit the different needs of a worldwide customer base. An easy option to consider when beginning a GIS program is to start with free programs. ArcGIS online is not only free, but there is no installation involved. All that is required is computers with internet access.

Teacher Training: Teachers need to know what they can do with GIS, understand why they should use GIS in the classroom, and learn how to access the technology and data to provide the instruction. Without prior experience, many teachers don't know how to get started with GIS, nor do they have the time

to take classes on the subject. Esri provides free and simplified online instruction that can be accessed at the users' convenience. Teachers can access instructional materials twenty-four hours a day, every day of the week for self-paced, independent study. In many of the online trainings, participants can leave a session, then later resume where they left off. These trainings combine video, text, illustrations, and interactive involvement to ensure understanding of the material. In addition to short online training seminars, there are web courses, podcasts, real-time instructor-led web courses, and short instructional tips at the Education Community Blog. At the ArcGIS Resource Center, forums can be found that will answer software questions for users. Starting with ArcGIS Online is the easiest route to bring GIS instruction into the classroom. It easily integrates into any class with computers and an internet connection. A short orientation is all that is required to provide instruction at any level. As students at Clark achieved success with high level projects, administrators increased their support of the program and took steps to formalize instruction centering on GIS.

**Instructional time:** Another potential roadblock to offering GIS classes in a school's curriculum is the emphasis on instructional standards. With State standardized tests every spring, school funding and teacher accountability tied to student test results, no teacher has a moment to spare in a core academic classroom. GIS easily integrates into academic subjects. By replacing outdated worksheet assignments or hand-drawn posters with interactive and visually engaging GIS lessons, students can have the benefit of cutting-edge technology training in addition to a more thorough understanding of subject material.

**Filling enrollment:** Many students have no room for elective classes in a course schedule tightly packed with required curriculum that will be tested by the state each year. One way to avoid this conundrum is to integrate GIS into core curriculum courses. Integration of GIS into a specific subject area also serves to generate student interest for the course. It would be unreasonable to expect students to enroll in a GIS course when they have never experienced or even heard of GIS. Offering the course as a familiar or required topic generates more interest. In this "head fake" approach, students are taught GIS, a valuable life skill, under the guise of a completely different subject.

**Teacher salaries:** By offering integrated courses as Career Technical Education (CTE), funding sources outside the district are made available. The Regional Occupation Program (ROP) covers a significant portion of teacher salaries for ROP classes.

Developing new course outlines: Creating a new course involves designing one or more course outlines, depending on how the course will be offered. The questions to be addressed are: Will the class be offered only at the district level, or will it be offered as Regional Occupation Program? Will the class be University of California (UC) “a-g” approved? Separate outlines with different formats will need to be developed for each of these options to conform to guidelines on referencing course standards. The ROP format doesn’t include academic standards, but ROP Foundation Standards and Pathway Standards must be referenced by number and have explicit student outcomes associated with them. Following are eleven Foundation Standards that all CTE courses share in common:

- 1.0 Academics
- 2.0 Communications
- 3.0 Career Planning and Management
- 4.0 Technology
- 5.0 Problem Solving and Critical Thinking
- 6.0 Health and Safety
- 7.0 Responsibility and Flexibility
- 8.0 Ethics and Legal Responsibilities
- 9.0 Leadership and Teamwork
- 10.0 Technical Knowledge and Skills
- 11.0 Demonstration and Application

Pathway Standards reflect specific knowledge and skills integral for the career introduced by a particular course. An example of a Pathway standard for the Environmental and Natural Sciences pathway is shown by standard E2.0: “Students study and understand the fundamentals of earth science as they relate to environmental engineering.” Pathway Standards were designed by combining existing CTE standards, academic standards and standards from business and industry. (CDE 2005)

Outlines for academic classes in the Glendale Unified School District do not reference CTE standards, but must list which academic standards are covered, how these standards will be applied in class, the percentage of class time spent on each standard, what sections of the course textbook are covered to teach those standards, and what assessments will be used to test students’ understanding of the standards.

UC CTE integrated courses count both ROP and academic standards equally. An integrated course outline for the UC system must list student outcomes based on academic standards alongside outcomes based on CTE standards. In contrast to the ROP format, specific standards and reference numbers should not be included. The UC format requires much more detail; a submission must include laboratory activities, key assignments, instructional methods and/or strategies and assessments.

### **Pedagogy**

The Rigor/Relevance Framework developed by the International Center for Leadership in Education consists of four quadrants; Acquisition (A), Application (B), Assimilation (C), and Adaptation (D). Students taking any one of the GIS courses at Clark Magnet High School experience all four levels of the Rigor/Relevance Framework. Memorization and understanding of knowledge represents quadrant “A” learning. Solving problems, designing solutions, and completing work signify quadrant “B” learning. Routinely using skills to craft unique solutions is quadrant “C” learning. Quadrant “D” learning is shown by reasoning in complex ways to deal with unknown variables. Clark students are also able to apply their acquired information and skills to create solutions and increase their skills and knowledge in other academic and real-life areas.

In the Marine Science Research class, students acquire basic GIS skills by working through the exercises in the Esri publication, *Getting to Know ArcGIS*. Skills are applied in end of quarter projects when students must use acquired knowledge to complete mapping and basic analysis of a study area without the step-by-step instructions from the textbook. Assimilation and adaptation of skills are accomplished through a final project. This project requires students to choose a target species to research. They review scientific literature to learn the biology and ecology of the species. Using data obtained from valid sources, students map the abundance and distribution of their species throughout the study area. They can then analyze what factors affect the patterns of abundance and distribution displayed by their project, and predict the probability the species would be present in a location not yet surveyed.

The GIS lab at Clark Magnet is maintained with the latest version of ArcInfo software and additional extensions for specialized geoprocessing functions. Regardless of whether publicly available free software is used, or high-end professional programs are put into play, the five steps of geographic inquiry

can be applied to each of the five levels of instructional use of GIS. The five steps of geographic inquiry are:

- Ask a geographic question
- Acquire geographic resources
- Explore geographic data
- Analyze geographic information
- Act on geographic knowledge

(Esri, 2011)

The first level of geographic instructional use is to show students a presentation or demonstration of the software. Working in pairs or small groups, students should be prompted to identify geographic questions related to the lesson. ArcGIS Online provides data students can easily acquire to answer geospatial questions. Exploring geographic data through visualization in maps, graphs and charts allows students to see patterns through analysis and relationships in the data. Students can then act on their geographic knowledge and use the results to educate, make a decision or solve a problem. A teacher demonstration could be used to introduce a class project. Additional technology such as a SmartBoard™ or SmartResponders™ can increase students' engagement and participation in the lesson.

In the second level of geographic instruction, students can work alone or in pairs on a scripted activity. Students search for answers on provided geographic questions, use and explore geographic data provided to analyze the information in order to find a predetermined result. This low level of GIS instructional use still allows students to reach the final level of geographic inquiry and act on their findings to educate, make a decision or solve a problem. Students could then write a technical or scientific report summarizing the project and giving recommendations based on their results.

The third level of geographic instruction expands the scripted activity, giving students some leeway to ask additional geographic questions and choose the type of analysis they use on provided data. Acting on geographic knowledge could be performed, for example, by having students share the diverse maps they've made with the class. As students become proficient with level one and level two instruction, they should be given the opportunity to move to a level three instruction in order to keep their interest strong.



Directed projects are at the fourth level of geographic instruction. Students create a directed project around a focus and a structured design that is presented to them, but they ask the questions, acquire the data, explore and analyze the data, then decide what actions to take in order to educate, make a decision or solve a problem based on the results of their analysis. At this level of learning, students begin to be encouraged by their ability to take charge of their own learning. They begin to realize the power of GIS and its relevance for applications in their own lives. This realization builds students' confidence and readies them for the next level of instruction.

At the fifth level of instruction, students customize a project. They choose the geographic questions to answer, acquire the appropriate data for exploration and analysis, then decide what angle to take in solving a problem and how to accomplish that goal. Fourth and fifth level geographic instruction exemplifies adaptation of instructional materials from a broad spectrum of courses. This adaptation empowers students to create solutions to real-world problems when confronted with unexpected challenges. The Rigor/Relevance Framework meshes seamlessly with teaching geographic inquiry and geographic instructional levels. GIS (even the free online version), gives teachers a powerful tool to facilitate advanced learning.

Another pedagogical technique that is exemplified in GIS classes is constructionist learning. Dr. Seymour Paper put forth constructionism as an idea that learning is more effective when learners are active in developing a product. Dr. Papert has a distinguished background as a mathematician and an early pioneer of Artificial Intelligence. He has been described as "The foremost expert on how technology can provide new ways to learn." As a professor at Massachusetts Institute of Technology, Papert has been conducting research in educational technology since the 1960s. (MIT Media Lab 2007) Papert outlined his "Eight Big Ideas Behind the Constructionist Learning Lab," as a way to convey his theory of effective learning. GIS classes at Clark Magnet embody every one of these eight ideas put forth by Papert. "The first big idea is *learning by doing*." GIS students are very active learners. With class projects, students choose what they want to create. They learn to make maps by experimenting with tools and geoprocesses to create and personalize an oftentimes artistic piece of work. "The second big idea is *technology as building material*." Technology is a prevalent part of society today. Students who grow up surrounded by technology easily learn new technological skills, and have a greater interest in applying technology in an

educational setting than they do in learning material without technology. Creating poster projects with GIS technology is far more relevant than traditional construction paper, colored markers, and glitter and glue projects. “The third big idea is *hard fun*.” Solving problems with GIS bring great rewards on many levels. The more difficult the problem, the greater the sense of accomplishment is after solving the challenge. “The fourth big idea is *learning to learn*.” Reminiscent of the Environmental and Spatial Technology (EAST) model of learning, new GIS students are given short assignments using software the instructor is not well versed in, such as recording a virtual tour of a study area in Google Earth, or creating an ROV design in Google Sketchup. Advanced GIS users are encouraged to explore and learn new extensions of ArcGIS. It is unrealistic to enroll in a class any time a new skill needs to be learned. By the instructor not being willing or able to guide instruction for every task assigned, it forces the student to take the initiative to read the help menu, find an online tutorial, or research answers through online forums for ideas to solve a problem. “The fifth big idea is *taking time* – the proper time for the job.” Students in the basic GIS class are told the date by which all the exercises in the textbook need to be finished. Students work at their own pace, and individual assignments only receive credit when they are complete and one-hundred percent correct. The instructor will play the part of the pace car, and activate assignment grades to keep students on task. Advanced students learn a module on project management. They are fully responsible to meet all timelines and project deliverables as a team. “The sixth big idea is the biggest of all: *you can’t get it right without getting it wrong*.” As beginning GIS users, students have the opportunity to fix mistakes and resubmit their work. It is more important that they meet the objectives of each assignment and learn to do the skill correctly rather than just turning in substandard work to meet a due date. “The seventh big idea is *do unto ourselves what we do unto our students*.” As a GIS instructor, there is always something new to learn and share. That is what keeps the class fresh and exciting, the discovery of learning. It never fails that students will end up teaching the teacher a new trick or technique that is highly beneficial to all when passed along. This is especially true in advanced classes where students and teacher push each other to find solutions through GIS technology. “The eighth big idea is *we are entering a digital world* where knowing about digital technology is as important as reading and writing.” The main point in teaching GIS as CTE is that this technology is growing. The application for GIS in education, jobs and careers are endless.

## **Science, Technology, Engineering, Arts, Mathematics**

The fear that the United States is losing competitiveness in the global market has resulted in a government push for Science Technology Engineering Mathematics, more commonly known as STEM, to be emphasized in education. In addition, more recent studies that consider the viewpoints of employers find that creativity is highly valued in employees. (The Conference Board 2008) John Tarnoff used the results of the 2008 Conference Board report, "Ready to Innovate," in a Huffington Post article, "STEM to STEAM -- Recognizing the Value of Creative Skills in the Competitiveness Debate." In the article he states, "There is certainly no question that STEM education and STEM skills are a vital part of this country's edge, but many educators would argue that STEM is missing a key set of creativity-related components that are equally critical to fostering a competitive and innovative workforce, and those skills are summarized under the letter "A" for Arts." Tarnoff makes a case for STEAM education noting, "Companies want workers who can brainstorm, problem-solve, collaborate creatively and contribute/communicate new ideas." GIS in the context of CTE encompasses art and creativity through cartography. Brainstorming, problem-solving, collaboration and communication are infused throughout GIS instruction from the level of extended script assignments to directed projects and custom projects.

## **Future Steps for Clark Magnet High School**

With the use of GIS growing in industry, K-12 education should offer training to students that will build a competitive workforce in a global marketplace. Teaching GIS will not only spark the creativity and maintain the interest of instructors, but will teach the students the skills they need to succeed in a changing world. The next steps to take at CMHS are to:

1. Expand the student GIS internship with the City of Glendale.
2. Follow-up with FEMA on the offer to create a student Hazus-MH certificate for the Geology of Disasters course.
3. Begin teacher training for entry-level GIS lessons during regularly scheduled staff development days.

4. Institute a GIS training section in the Technology Literacy course that is mandatory for all incoming freshmen.
5. Submit Marine Science Research as a new course to LA County ROP. This course will replace robotics instruction with a unit on biotechnology. A new partnership with the Coastal Marine Biolabs will provide teacher training, tissue samples and equipment in order for students to extract and analyze DNA of local marine creatures and upload genetic information to add to the growing online database in the “Barcoding Life’s Matrix” program. This project will be incorporated in the final project of mapping abundance and distribution of marine life in the Channel Islands National Marine Sanctuary.
6. Formalize post-secondary pathways
  - a. Assist local community colleges in building a successful GIS program.
  - b. Consistently promote the GIS certificate and degree programs at California State University, Northridge.
  - c. Create an articulation agreement with CSUN for GIS classes.
7. Create a specialized geospatial academy at Clark Magnet.

## REFERENCES

- Anonymous. "Teaching by Doing: PPGIS and Classroom-Based Service Learning." *Urban and Regional Information Systems Association*. URISA, Jan. 2006. Web. Retrieval date: 27 Dec. 2011.  
<[http://www.urisa.org/publications/journal/articles/teaching\\_by\\_doing\\_PPGIS](http://www.urisa.org/publications/journal/articles/teaching_by_doing_PPGIS)>
- Bishop, John H. and Mane, Ferran. "The impacts of career-technical education on high school labor market success." *Economics of Education Review* 23 (2004) 381-402.
- Castellano, Marisa and Stringfield, Sam. "Secondary Career and Technical Education and Comprehensive School Reform: Implications for Research and Practice." *Review of Educational Research*, Summer 2003, Vol. 73 no. 2 231-272.
- "Closing the Expectations Gap | Achieve.org." *Achieve, Inc.* American Diploma Project Network, Feb. 2011. Web. Retrieval date: 26 Dec. 2011. <<http://www.achieve.org/closing-expectations-gap>>.
- "Geographic Inquiry: Thinking Geographically." *Esri Schools and Libraries Program*, 2003. Web. Retrieval date: 28 Dec. 2011.  
< <http://www.esri.com/industries/k-12/PDFs/geoginquiry.pdf>>
- Johansson, Tino. "GIS in Teacher Education — Facilitating GIS Applications in Secondary School Geography." *Scangis.org*, 2003. Web. Retrieval date: 26 Dec 2011.  
<<http://www.scangis.org/scangis2003/papers/20.pdf>>
- Lichtenburg, James, Woock, Christopher, and Mary Wright. "Ready to Innovate; Are Educators and Executives Aligned on the Creative Readiness of the U.S. Workforce?" *The Conference Board*, 2008. Web, Retrieval date: 27 Dec 2011.  
<[http://www.artsusa.org/pdf/information\\_services/research/policy\\_roundtable/ReadytoInnovateFull.pdf](http://www.artsusa.org/pdf/information_services/research/policy_roundtable/ReadytoInnovateFull.pdf)>
- Lynch, Richard L. "New Directions for High School Career and Technical Education in the 21<sup>st</sup> Century." *ERIC Clearinghouse on Adult, Career and Vocational Education Center on Education and Training for Employment*, 2000. Web, Retrieval date: 27 Dec 2011.  
< <http://www.calpro-online.org/eric/docs/lynch/lynch1.pdf>>

Plank, Steven. "Career and Technical Education in the Balance: An Analysis of High School Persistence, Academic Achievement, and Postsecondary Destinations." *National Research Center for Career and Technical Education, St. Paul, MN*. 2001. Web. Retrieval date: 26 Dec. 2011.

<<http://eric.ed.gov/PDFS/ED461721.pdf>>

Plank, Steven, DeLuca, Stephanie, Estacion, Angela. "Dropping out of High School and the Place of Career and Technical Education: A Survival Analysis of Surviving High School." *National Research Center for Career and Technical Education, St. Paul, MN*. 2005. Web. Retrieval date: 26 Dec. 2011

<<http://eric.ed.gov/PDFS/ED497348.pdf>>

Rojewski, Jay W. "Preparing the Workforce of Tomorrow: A Conceptual Framework for Career and Technical Education." *Journal of Vocational Education Research*, 27(1) pp.7-35. 2002.

Saunders, Marisa, and Christopher Chrisman. "Linking Learning to the 21st Century: Preparing All Students for College, Career, and Civic Participation | National Education Policy Center." *National Education Policy Center | School of Education, University of Colorado at Boulder*. Apr. 2011. Web. Retrieval date: 26 Dec. 2011. <<http://nepc.colorado.edu/publication/linking-learning>>.

Stager, Gary. "Papertian Constructionism and the Design of Productive Contexts for Learning." *Plenary Session Paper — EuroLogo X, Warsaw, Poland — August 28-31, 2005*. Web. Retrieval date: Dec 27 2011.

<<http://stager.org/articles/eurologo2005.pdf>>

Tarnoff, John. "From STEM to STEAM – Recognizing the Value of Creative Skills in the Competitiveness Debate." *Huff Post Education* Oct. 2010. Web. Retrieval date: 28 Dec. 2011

<[http://www.huffingtonpost.com/john-tarnoff/stem-to-steam-recognizing\\_b\\_756519.html](http://www.huffingtonpost.com/john-tarnoff/stem-to-steam-recognizing_b_756519.html)>

United States. American Youth Policy Forum. Publications Department 1836 Jefferson Place NW Washington, DC 20036. *Rigor and Relevance: A New Vision for Career Technical Education*. By Betsy Brand. American Youth Policy Forum, Apr. 2003. Web. Retrieval date: 26 Dec. 2011. <[www.aypf.org](http://www.aypf.org)>.

Wai, Johnathan, Lubinski, David, and Benbow, Camilla P. "Spatial Ability for STEM Domains: Aligning Over 50 Years of Cumulative Psychological Knowledge Solidifies Its Importance." *Journal of Educational Psychology*, 2009. Vol 101, No. 4, 817-835.

## APPENDIX A: GUSD COURSE OUTLINE ENVGIS

### GLENDALE UNIFIED SCHOOL DISTRICT

#### Senior High School

Department:	Science
Course Title:	Environmental Geographic Information Science
Course Number:	7128 and 7129
Grade Level:	11-12
Semester Hours:	10 (2 semesters)
Prerequisites:	Technology Literacy, Biology 1-2, Science Research (B or better required in all courses, or instructor approval)
Course Description:	<p>This course will provide a basic understanding of ArcGIS mapping software and GPS technology. This is a course for juniors and seniors who are prepared to apply concepts learned in Biology and Technology Literacy to real-world problems. Students will participate collaboratively in a field research group project focused on an environmental issue. Students will increase their skills and knowledge in science, laboratory work, research skills, and computer technology by applying academic content in their research and course studies. <b>This class does not replace a core science course.</b></p>

Graduation Requirement: College Prep Elective

This class provides an academically challenging course in scientific research in the following fields of Biology, Geography and the physical sciences. This course will require students to apply their academic knowledge to the problem solving tasks associated with scientific research. It is the objective of this course to enable students to apply their knowledge of life and physical sciences while working with professionals who will provide mentorship on researching a specific topic in science applicable to the mentor's field of research and the student's field of interest. The students will utilize literature research skills (library/computer/internet) to begin their projects. Students will present the results of their work in both formal written documents and public forums to further develop their written and oral presentation skills. In the classroom they will continue to deepen their knowledge in their chosen field of research and enlighten their peers.

California Standard: Ecology. This standard states:  
“Stability in an ecosystem is a balance between competing effects.”

As a basis for understanding this concept:

- a. Students know biodiversity is the sum total of different kinds of organisms and is affected by alterations of habitats.
- b. Students know how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, or changes in population size.
- c. Students know how fluctuations in population size in an ecosystem are determined by the relative rates of birth, immigration, emigration, and death.
- d. Students know how water, carbon, and nitrogen cycle between abiotic resources and organic matter in the ecosystem and how oxygen cycles through photosynthesis and respiration.
- e. Students know a vital part of an ecosystem is the stability of its producers and decomposers.

California Standard: Investigation and Experimentation. This standard states:

“Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations.”

I. Student Learning Objective

The student will:

- A. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
- B. Identify and communicate sources of unavoidable experimental error.
- C. Identify possible reason for inconsistent results, such as sources of error or uncontrolled conditions.
- D. Formulate explanations using logic and evidence.
- E. Recognize the usefulness and limitations of models and theories as scientific representations of reality.
- F. Create and design topographic and geologic maps.
- G. Recognize the issues of statistical variability and the need for controlled tests.



- H. Recognize the cumulative nature of scientific evidence.
  - I. Analyze situations and solve problems that require combining and applying concepts from more than one area of science.
  - J. Investigate a science-based societal issue by researching the literature, analyzing the data, and communicating the findings. Examples of issues include effects of Marine Protected Areas, biomagnification in marine life, and oil platforms as artificial reefs in California.
- II. Additional Learning Objectives:
- A. Students will increase their understanding of life and/or physical sciences and demonstrate their ability to solve problems and think critically by effectively completing literature searches in their field of research, which can include but is not limited to the fields of Biology, Geography, Geology, Chemistry,
  - B. The student will develop a clear understanding of the research area he/she is researching and will demonstrate this knowledge by describing the following:
    - 1. Standard research technology and equipment used for laboratory tests that are routinely performed, and the professionals involved.
    - 2. Students will become familiar with all professions in the focused research area and will write a description of each.
    - 3. Students will be given an area of research to construct their own hypothesis and test their ideas.
  - C. Students will develop advanced technical reading and writing skills and will be able to understand and critically evaluate the content of scientific text and print materials.
  - D. Students will investigate factual material for information and analysis and will be able to write in a technical/scientific style with appropriate composition.
  - E. Students will understand and be able to apply and document common research methods:
    - 1. Identify problems and unresolved resource needs
    - 2. Formulate hypotheses based on problem identification
    - 3. Create an appropriate investigative/experimental design to test a hypothesis
    - 4. Utilize statistics to analyze experimental data
    - 5. Document observations, inferences and conclusions from data
  - F. Students will produce a resource, which involves the application of the discipline areas (science, technology, and English). This resource will be useful to the community, and will be accompanied by written and statistical support, and will be presented as a culmination and demonstration of skill developed in the class.

G. Students will submit a scientifically formatted paper for publication.

II. Sample Assessments

A. Traditional forms of assessment

1. Written reports including research, evaluation, and lab reports
2. Written tests
3. Individual oral/visual presentations

B. Project Based

1. Project selection and development
2. Literature review
3. On-going cumulative portfolio record of project and accomplishments
4. Group presentations (as necessary)
5. Individual presentation to the professional scientific community (conference or science fair)
6. Final project
7. Individual assessment

III. Topic of Study - Suggested Time Distribution

This class is a research-based class therefore time-lines and topics are student specific.

- |   |     |
|---|-----|
| 1. Project selection, student research, computer mapping, |     |
| Literature reviews  | 75% |
| 2. Presentations to fellow classmates                     | 10% |
| 3. Final project and other assessments                    | 10% |
| 4. Attending symposiums                                   | 5%  |

IV. Recommended Materials

A. Texts for Environmental GIS include:

1. *Getting to Know ArcGIS Desktop* ESRI Press (core)
2. *Mapping Our World; GIS for Educators* ESRI Press (supplemental)
3. *The Ecology of Marine Fishes; California and Adjacent Waters* University of California Press (supplemental)

B. Community partners willing to provide data and expertise include:

1. Ventura County Sheriff's Search and Rescue
2. National Oceanic Atmospheric Administration
3. Bureau of Ocean Energy Management, Regulation and Enforcement
4. California Department of Fish and Game
5. California State University, Northridge

## APPENDIX B: GUSD COURSE OUTLINE GOD A

Glendale Unified School District

Senior High School

March 20, 2012

Department: Science

Course Title: Geology of Disasters A

Course Number: 7238

Grade Level: 10-12

Semester Credits: 5

Recommended  
Prerequisite: Physics and Algebra I (concurrent enrollment)

Recommended  
Textbook: *Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes (3rd Edition)*, Edward A. Keller, Duane E. DeVecchio (2012) Prentice Hall

Course  
Description: The Geology of Disasters, a Hazus-MH Training Course is a Career Technical Education course integrating Earth Science standards. This course is appropriate for 10<sup>th</sup> through 12<sup>th</sup> grade students who are interested in the geologic features and processes behind natural disasters. Students will learn disaster preparedness planning and how to use free online mapping programs to monitor and communicate disaster locations and conditions. Section "A" not a required prerequisite for section "B."

### I. Standards

A. Dynamic Earth Processes  
Plate tectonics operating over geologic time has changed the patterns of land, sea, and mountains on Earth's surface. (3)

As the basis for understanding this concept:

1. Students know features of the ocean floor (magnetic patterns, age, and sea-floor topography) provide evidence of plate tectonics. 3.a
2. Students know the principal structures that form at the three different kinds of plate boundaries. 3.b
3. Students know how to explain the properties of rocks based on the physical and chemical conditions in which they formed, including plate tectonic processes. 3.c
4. Students know why and how earthquakes occur and the scales used to measure their intensity and magnitude. 3.d

5. Students know there are two kinds of volcanoes: one kind with violent eruptions producing steep slopes and the other kind with voluminous lava flows producing gentle slopes. 3.e
  6. Students know the explanation for the location and properties of volcanoes that are due to hot spots and the explanation for those that are due to subduction. \*3.f
- B. Energy in the Earth System  
Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.

As a basis for understanding this concept:

1. Students know how differential heating of Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat. 5.a
  2. Students know the relationship between the rotation of Earth and the circular motions of ocean currents and air in pressure centers. 5.b
  3. Students know the origin and effects of temperature inversions. 5.c
  4. Students know properties of ocean water, such as temperature and salinity, can be used to explain the layered structure of the oceans, the generation of horizontal and vertical ocean currents, and the geographic distribution of marine organisms. 5.d
  5. Students know rain forests and deserts on Earth are distributed in bands at specific latitudes. 5.e
  6. Students know the interaction of wind patterns, ocean currents, and mountain ranges results in the global pattern of latitudinal bands of rain forests and deserts. \*5.f
  7. Students know features of the ENSO (El Niño southern oscillation) cycle in terms of sea-surface and air temperature variations across the Pacific and some climatic results of this cycle. \*5.g
- C. Climate is the long-term average of a region's weather and depends on many factors.

As a basis for understanding this concept:

1. Students know weather (in the short run) and climate (in the long run) involve the transfer of energy into and out of the atmosphere. 6.a
2. Students know the effects on climate of latitude, elevation, topography, and proximity to large bodies of water and cold or warm ocean currents. 6.b
3. Students know how Earth's climate has changed over time, corresponding to changes in Earth's geography, atmospheric composition, and other factors, such as solar radiation and plate movement. 6.c
4. Students know how computer models are used to predict the effects of the increase in greenhouse gases on climate for the planet as a whole and for specific regions. \*6.d

#### D. California Geology

The geology of California underlies the state's wealth of natural resources as well as its natural hazards.

As a basis for understanding this concept:

1. Students know the resources of major economic importance in California and their relation to California's geology. 9.a
2. Students know the principal natural hazards in different California regions and the geologic basis of those hazards. 9.b
3. Students know the importance of water to society, the origins of California's fresh water, and the relationship between supply and need. 9.c
4. Students know how to analyze published geologic hazard maps of California and know how to use the map's information to identify evidence of geologic events of the past and predict geologic changes in the future. \*9.d

#### E. Investigation and Experimentation

Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations. Students will:

1. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
2. Identify and communicate sources of unavoidable experimental error.
3. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
4. Formulate explanations by using logic and evidence.
5. Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions.
6. Distinguish between hypothesis and theory as scientific terms.
7. Recognize the usefulness and limitations of models and theories as scientific representations of reality.
8. Read and interpret topographic and geologic maps.
9. Analyze the locations, sequences, or time intervals that are characteristic of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).
10. Recognize the issues of statistical variability and the need for controlled tests.
11. Recognize the cumulative nature of scientific evidence.
12. Analyze situations and solve problems that require combining and applying concepts from more than one area of science.

13. Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.

F. Career Technical Education Environmental and Natural Science Engineering Pathway Standards

- E2.0 Students study and understand the fundamentals of earth science as they relate to environmental engineering:
- E2.1 Students classify the three major groups of rocks according to their origin on the basis of texture and mineral composition.
- E2.2 Students analyze the importance and use of soil, and evaluate how soil may be preserved and conserved.
- E2.3 Students know how to assess and evaluate geological hazards.
- E2.4 Understand how to read, interpret, and evaluate topographical maps and images.
- E2.5 Use global positioning systems equipment and related technology to locate and evaluate soil or geological conditions or features.
- E2.6 Analyze soil erosion and identify the causes.
- E3.0 Students understand the effects of the weather, the hydrosphere, and the atmosphere on the environment:
- E3.1 Understand the effects of weather fronts on regional air pollution.
- E3.2 Know the common causes of atmospheric contamination.
- E3.3 Analyze atmospheric pressure and weather systems.
- E3.4 Know the major systems used to monitor, analyze, and predict conditions of meteorological events.
- E3.5 Analyze the mechanisms for air mass movement.
- E3.6 Understand the relationship between the health of the marine environment and climate control.
- E3.7 Understand the effects of human activity on the atmospheric environment.

- G. Sample Assessments
1. Formative assessments – checks for understanding, acquisition of information
  2. Section quizzes – confirms assimilation of subject material
  3. Written composition and reports – demonstrates application of subject material and literacy in the content area
  4. Laboratory exercises – practical application of subject area
  5. Laboratory Manual in Physical Geology
  6. What is Science? A process and a body of knowledge (Incorporating Observing and Measuring Earth Materials and Processes, Laboratory One Laboratory Manual in Physical Geology)
  7. Data collection in the field – San Andreas Fault in Palmdale
  8. Rock Forming Processes and the Rock Cycle (Laboratory Four)
  9. Earthquake Hazards and Human Risks (Laboratory Sixteen)
  10. Stream Processes, Landscapes, Mass Wastage, and Flood Hazards (Laboratory eleven)
  11. Groundwater Processes, Resources, and Risks (Laboratory Twelve)
  12. Unit tests – assesses comprehension of material
  13. Interim assessments – assesses mastery of subject
  14. Presentations – learning is further developed by teaching others
  15. Midterm – assesses comprehension and retention of material
  16. Comprehensive final – assesses comprehension and retention of material
  17. Capstone project – documents students’ ability to adapt course material to real-world predictable and unpredictable situations

III. Topic of Study - Suggested Time Distribution

A.	Dynamic Earth Processes	25%
B.	Energy in the Earth System	25%
C.	California Geology	25%
D.	Investigation and Experimentation standards	25%

- IV. Recommended Materials  
 Laboratory Manual in Physical Geology  
 Eighth Edition, Pearson/Prentice Hall  
 Richard M. Busch, Editor

## APPENDIX C: GUSD COURSE OUTLINE GOD B

Glendale Unified School District

Senior High School

March 20, 2012

Department: Science

Course Title: Geology of Disasters B

Course Number: 7239

Grade Level: 10-12

Semester Credits: 5

Recommended Prerequisite: Physics and Algebra I (concurrent enrollment)

Recommended Textbook: FEMA Hazus-MH workbooks will be used

- 313 Basic Hazus-MH
- 174 Hazus-MH for Earthquake
- 172 Hazus-MH for Flood
- 296 Application of Hazus-MH for Risk Assessment
- 317 Comprehensive Data Management

Course Description: The Geology of Disasters, a Hazus-MH Training Course, is a Career Technical Education course integrating Earth Science standards with Environmental and Natural Science Engineering pathway standards. This course is appropriate for 10<sup>th</sup> through 12<sup>th</sup> grade students who are interested in disaster preparedness planning and mitigation with geographic information systems. The major focus of the Geology of Disasters course is to prepare students to do risk analysis, loss estimation and evaluate mitigation techniques for earthquake, flood and hurricane wind disasters. Students will employ GIS analysis integrated with cartographic and scientific concepts for the investigation of disaster related problems. Students will develop problem-solving skills and apply their knowledge of research and design to create solutions to various challenges throughout the course. Students will also learn how to document their work, and communicate their findings to their peers and members of the professional community. Section "A" not a required prerequisite for section "B."

### I. Standards

#### A. Dynamic Earth Processes

Plate tectonics operating over geologic time has changed the patterns of land, sea, and mountains on Earth's surface. (3)

As the basis for understanding this concept:

1. Students know features of the ocean floor (magnetic patterns, age, and sea-floor topography) provide evidence of plate tectonics. 3.a



2. Students know the principal structures that form at the three different kinds of plate boundaries. 3.b
3. Students know why and how earthquakes occur and the scales used to measure their intensity and magnitude. 3.d

B. Climate is the long-term average of a region's weather and depends on many factors.

As a basis for understanding this concept:

1. Students know weather (in the short run) and climate (in the long run) involve the transfer of energy into and out of the atmosphere. 6.a
2. Students know the effects on climate of latitude, elevation, topography, and proximity to large bodies of water and cold or warm ocean currents. 6.b
3. Students know how computer models are used to predict the effects of the increase in greenhouse gases on climate for the planet as a whole and for specific regions. \*6.d

C. California Geology  
The geology of California underlies the state's wealth of natural resources as well as its natural hazards.

As a basis for understanding this concept:

1. Students know the resources of major economic importance in California and their relation to California's geology. 9.a
2. Students know the principal natural hazards in different California regions and the geologic basis of those hazards. 9.b
3. Students know how to analyze published geologic hazard maps of California and know how to use the map's information to identify evidence of geologic events of the past and predict geologic changes in the future. \*9.d

D. Investigation and Experimentation  
Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations. Students will:

1. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
2. Identify and communicate sources of unavoidable experimental error.
3. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
4. Formulate explanations by using logic and evidence.

5. Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions.
6. Distinguish between hypothesis and theory as scientific terms.
7. Recognize the usefulness and limitations of models and theories as scientific representations of reality.
8. Read and interpret topographic and geologic maps.
9. Analyze the locations, sequences, or time intervals that are characteristic of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).
10. Recognize the issues of statistical variability and the need for controlled tests.
11. Recognize the cumulative nature of scientific evidence.
12. Analyze situations and solve problems that require combining and applying concepts from more than one area of science.
13. Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.

E. Career Technical Education Environmental and Natural Science Engineering Pathway Standards

- E1.0 Students know how to communicate and interpret information clearly in industry-standard visual and written formats:
- E1.2 Know the current industry standards for illustration and layout.
- E2.0 Students study and understand the fundamentals of earth science as they relate to environmental engineering:
- E2.3 Students know how to assess and evaluate geological hazards.
- E2.4 Understand how to read, interpret, and evaluate topographical maps and images.
- E2.5 Use global positioning systems equipment and related technology to locate and evaluate soil or geological conditions or features.
- E3.0 Students understand the effects of the weather, the hydrosphere, and the atmosphere on the environment:
- E3.3 Analyze atmospheric pressure and weather systems.
- E3.4 Know the major systems used to monitor, analyze, and predict conditions of meteorological events.

- E3.5 Analyze the mechanisms for air mass movement.
- E3.6 Understand the relationship between the health of the marine environment and climate control.
- E3.7 Understand the effects of human activity on the atmospheric environment.
- E5.0 Students understand the design process and how to solve analysis and design problems:
- E5.1 Understand the steps in the design process.
- E5.2 Determine what information and principles are relevant to a problem and its analysis.
- E5.3 Choose between alternate solutions in solving a problem and be able to justify choices in determining a solution.
- E5.5 Understand the process of developing multiple details into a single solution.
- E8.0 Students understand fundamental automation modules and know how to set up simple systems that will complete preprogrammed tasks:
- E8.1 Use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data in a simulated or modeled automated system.
- E9.0 Students understand the effective use of environmental and natural science equipment:
- E9.1 Use appropriate methods and techniques for employing environmental and natural science equipment.
- E9.2 Apply conventional environmental and natural science processes and procedures accurately, appropriately, and safely.
- E9.3 Apply the concepts of environmental and natural science to the tools, equipment, projects, and procedures of the Environmental and Natural Science Engineering Pathway.

## II. Sample Assessments

- A. Formative assessments – checks for understanding, acquisition of information
- B. Assigned unit exercises using Hazus-MH – allows students practice and familiarity with Hazus-MH software
- C. Section quizzes – confirms assimilation of subject material
- D. Written composition and reports – demonstrates application of subject material and literacy in the content area
- E. Unit tests – assesses comprehension of material
- F. Interim assessments – assesses mastery of subject

- G. Presentations – learning is further developed by teaching others
- H. Midterm – assesses comprehension and retention of material
- I. Comprehensive final – assesses comprehension and retention of material
- J. Capstone project – documents students’ ability to adapt course material to real-world predictable and unpredictable situations

III. Topic of Study – Suggested Time Distribution

- |    |   |     |
|----|---|-----|
| A. | Dynamic Earth Processes                     | 3%  |
| B. | Energy in the Earth System                  | 6%  |
| C. | California Geology                          | 16% |
| D. | Investigation and Experimentation standards | 75% |

**APPENDIX D: LACOE ROP COURSE OUTLINE ENVGIS**



*Los Angeles County  
Office of Education*



*Los Angeles County  
Regional Occupational Program*

**Title:** Environmental Geographic Information System

**Job Titles:** Engineering Technicians  
Environmental Engineering Technician  
Hazardous Materials Removal Worker

**Course Description:**

Environmental Geographic Information System (Env GIS) is a course that is appropriate for 11<sup>th</sup> and 12<sup>th</sup> grade students who are interested in GIS and environmental issues. The major focus of the EnvGIS Course is to expose students to research and analysis, teamwork, communication methods, global and human impacts, environmental standards, and technical documentation. EnvGIS gives students the opportunity to develop skills and understanding of course concepts through project-based learning.

Students will employ GIS analysis integrated with cartographic and scientific concepts for the solution of environmental and community problems. In addition, students use handheld GPS and remote sensing data from satellites, remotely operate vehicles or sonar in their analysis. Students will develop problem-solving skills and apply their knowledge of research and design to create solutions to various challenges throughout the course. Students will also learn how to document their work, and communicate their findings to their peers and members of the professional community.

This course aligns with and/or incorporates the California Career Technical Education Standards, LACOROP Expected Student Learning Results, English Language Arts and Mathematics Standards, and High School Exit Exam Standards.

Module	Module Title	Classroom Hours	OJT (CC) Hours	OJT (CVE) Hours
I	Career Essentials	12	0	0
II	Project Management	12	0	0
III	Research Design	12	0	0
IV	Data Collection	24	0	0
V	GIS Applications and Analysis	70	0	0
VI	Communicating Results	50	0	0
<b>Total Hours: 180</b>		<b>180</b>	<b>0</b>	<b>0</b>

**Los Angeles County Regional Occupational Program  
ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEM  
COURSE OUTLINE**

<b>Course Title</b>	Environmental Geographic Information System	<p><b>Course Description</b></p> <p>Environmental Geographic Information System (EnvGIS) is a course that is appropriate for 11<sup>th</sup> and 12<sup>th</sup> grade students who are interested in GIS and environmental issues. The major focus of the EnvGIS Course is to expose students to research and analysis, teamwork, communication methods, global and human impacts, environmental standards, and technical documentation. EnvGIS gives students the opportunity to develop skills and understanding of course concepts through project-based learning.</p> <p>Students will employ GIS analysis integrated with cartographic and scientific concepts for the solution of environmental and community problems. In addition, students use handheld GPS and remote sensing data from satellites; remotely operate vehicles or sonar in their analysis. Students will develop problem-solving skills and apply their knowledge of research and design to create solutions to various challenges throughout the course. Students will also learn how to document their work, and communicate their findings to their peers and members of the professional community.</p> <p>This course aligns with and/or incorporates the California Career Technical Education Standards, LACOROP Expected Student Learning Results English Language Arts and Mathematics Standards, and High School Exit Exam Standards.</p>
<b>CBEDS Code</b>	5574	
<b>State Course I.D.</b>	7090	
<b>ROP#</b>	17-304	
<b>Approval Date</b>	May 4, 2012	
<b>Revision Date</b>		
<b>Anchor Job Title &amp; SOC Code</b>	Engineering Technicians 17.3029.00 Environmental Engineering Technician 17-3025.00 Hazardous Materials Removal Workers 47-4041.00	
<b>CTE Industry Sector</b>	Engineering and Design	
<b>Career Pathway</b>	Environmental and Natural Science Engineering	
<b>UC Credit</b>	No	
<b>Certification</b>	No	
<b>Course Hours</b>	180	

### **Classroom Physical Environment:**

The classroom setting requires both a fully equipped computer lab with up to date ArcGIS software, GPS equipment, and poster supplies in sufficient quantity to train the number of students assigned to each instructor. Space conducive for a group theory lesson including flat student desks or worktables, whiteboard, file cabinet, teacher's chair and desk, computer tables to accommodate a class set of computers, plotter printer and Internet access will be provided. This facility must be equipped with adequate lighting and many electrical outlets (at least one outlet per every two students plus four additional).

### **Training OJT Environment:**

Title 5 Education Code No. 10085

The following criteria shall be used to select and approve a community classroom training station:

- (a) The management of the community classroom training station shall:
  - (1) Have a clear understanding of the community classroom methodology and a willingness to participate in the training experience.
  - (2) Cooperate with the career technical education director or his/her designee, in preparing a written joint venture agreement.
  - (3) Participate with the community classroom teacher in preparing an individualized training plan.
  - (4) Provide and assist students with unpaid on-the-job training experiences as described in the individualized training plan.
  - (5) Consult with the community classroom teacher regarding the student's progress during the unpaid on-the-job training experiences.
  - (6) Assist in maintaining accurate records of the pupil's training hours.
- (b) The training station shall offer training opportunities in the specific occupation for which the course is approved. Training opportunities at the station shall expand competencies developed in the classroom instruction portion of the student's training.
- (c) The training station shall have adequate equipment, materials, and other resources to provide an appropriate learning opportunity.
- (d) Training station conditions shall prevail which will not endanger the health, safety, welfare, or morals of the pupil.
- (e) The training station shall be concurrently engaged in a business operation, which requires employment in the occupation for which training is provided.

Ed. Code Title 5 10107

- (a) The employer at the cooperative career technical [CVE] training station shall:
  - (1) Have a clear understanding of program objectives and a willingness to participate in the program.
  - (2) Provide adequate supervision to ensure a planned program of the students' paid on-the-job training in order that the student may receive maximum education benefit.
  - (3) Consult with the cooperative career technical education teacher regarding the paid on-the-job progress of the student.
  - (4) Cooperate with the career technical education director or his or her designee in preparing a written training agreement.
  - (5) Participate with the cooperative career technical education teacher and the student in preparing an individualized training plan.
  - (6) Provide a minimum of 8 hours of paid employment per week to assist students to acquire those competencies necessary for employment and advancement in the occupational area for which training offered.
  - (7) Assist in maintaining accurate records of the students' training hours.
  - (8) Provide Workers' Compensation Insurance for students employed through the Cooperative Career Technical Education Program.
- (b) The training station shall offer training opportunities in the specific occupation for which the course is approved. Training opportunities at the paid station shall be in the occupation for which related instruction is provided.
- (c) Training station working conditions shall not endanger the health, safety, welfare or morals of the students.
- (d) The training station shall have adequate equipment, materials and other resources to provide an appropriate learning opportunity.

Rev: 1/25/2012

3

**Safety:**

- All students will successfully complete a safety exam with results kept on file.
- Specialized safety needs.

**Equipment and Materials:****Software**

- ArcGIS (ArcGIS desktop or ArcInfo)
- Additional GIS programs (optional)
  - Benthic Terrain Modeler
  - Hazus-MH
  - Marxan
  - Envi
  - ArcGIS Explorer
- GPS software
  - Pathfinder Office
  - Terrasync
  - ArcPad
- Microsoft Office suite
  - Word
  - Excel
  - PowerPoint
  - Publisher
  - Access
- Microsoft Active Sync
- Microsoft Project
- Google Earth
- Google Sketchup

**GPS:**

- Class set of Trimble handheld GPS (Juno or Geo series)

**Printers:**

- Plotter printer
- Color laser printer
- Black and white printer

**Miscellaneous Supplies:**

- Foam board
- Adhesive
- Poster paper
- Standard printer paper
- Printer ink

**Text**

Getting to Know ArcGIS Desktop by Ormsby et al.  
The GIS 20 Essential Skills by Gina Clemmer  
GIS Tutorial (versions 1, 2, and 3) Basic Workbooks by Gorr and Kurland

**Mentors**

CSUN  
CSULB  
BOEMRE  
NOAA  
Esri (Geomentors program)  
USC (QuikScience program)  
Community  
Corporate

Rev: 1/25/2012

4



**Magazines & Scientific Journals**

Conservation Biology  
Journal of Marine Biology  
Ecology  
Bulletin of Marine Science  
Science News  
Science News for Kids

**Reference Books**

The Ecology of Marine Fishes; California and Adjacent Waters  
Marine Geography; GIS for the Oceans and Seas  
Undersea with GIS  
Arc Marine; GIS for a Blue Planet  
GIS for Environmental Management  
Designing Better Maps; A guide for the GIS User  
Differential GPS Explained  
Invasive Plants: Guide to Identification and the Impacts and Control of Common North American Species  
Invasive Plants of California's Wildlands

**Electronic Resources**

Internet

**Methods, Strategies and Techniques**

- Lecture and Discussion
- Laboratory Activities which Emphasize Open-ended Hands-on Exploration and Investigation
- Team and Subspecialty Teamwork
- Exposure to Current Trends and Information in GIS through Reading Assignments in Current Periodicals and Journals
- Written Assignments Correlating with Concepts Presented in Lecture
- Independent and Group Research Projects
- Independent and Group GIS Projects
- Internet Research
- Enrichment Videos and Slide Presentations
- Collaboration with Mentors
- Possible Field Trips to Channel Islands, Local Foothills, Aquariums, GIS Day Events
- Training with field data collection equipment such as:
  1. Remotely operated vehicle
  2. Hand-held GPS

**Assessment of Student Performance:**

- Extensive Reading Assignments, Substantial Written Assignments, Internet Research
- Individual and Group Research Projects
- Problem-solving Activities
- Written Tests and Quizzes
- Accomplishment of Specific Goals in Subspecialty Teams
- Properly Formatted Maps
- Poster Presentations
- Paper Presentation

**LACOROP Certificate Requirements:**

- Student Prerequisites: Minimum age of 16 or 11<sup>th</sup> grade status.

**Special Instructor(s) Prerequisites:**

- Three years of training and experience in the field of engineering, electronics, or robotics.
- Valid California Driver's License

Rev: 1/25/2012

5

INSTRUCTIONAL CONTENT	STUDENT OUTCOMES	C	CC		CVE	
			R I	OJT	RI	OJT
<b>I. CAREER ESSENTIALS</b>		12				
<p>A. Personal Skills</p> <ul style="list-style-type: none"> <li>• Orientation/Introduction to ROP</li> <li>• Work Ethics</li> <li>• Entrepreneurship</li> </ul>	<ul style="list-style-type: none"> <li>• Relate philosophy, purpose, and goals of LACOROP to individuals needs.</li> <li>• Describe how course goals and objectives relate to individual needs/goals.</li> <li>• Define ethics and morals, and explain how these fit in the workplace. (FS 8.3; ESLR 4)</li> <li>• Describe the concept and application of ethical and legal behavior consistent with workplace standards. (FS 8.2)</li> <li>• Explain the concept and value of entrepreneurship in our society and identify characteristics of successful entrepreneurs.</li> </ul>					
<p>B. Interpersonal Skills</p> <ul style="list-style-type: none"> <li>• Diversity/Equity</li> <li>• Harassment</li> <li>• Customer Service</li> <li>• Optional Student Activities</li> </ul>	<ul style="list-style-type: none"> <li>• Describe why it is important to address diversity in work place and consequences if it is not.</li> <li>• Identify verbal, non-verbal, and physical types of harassment as defined by the state/federal law and determine appropriate behavior in the workplace. (FS 7.0)</li> <li>• Identify the components of good customer service and explain their worth in society.</li> <li>• Discuss effective leadership styles, key concepts of group dynamics, team and individual decision making, the benefits of workforce diversity, and conflict resolution. (FS 9.0; ESLR 1, 4)</li> </ul>					
<p>C. Thinking and Problem Solving Skills</p>	<ul style="list-style-type: none"> <li>• Identify the steps to problem solving and develop skills needed for critical thinking and solving problems (FS 5.0; ESLR 2)</li> </ul>					
<p>D. Communication Skills</p>	<ul style="list-style-type: none"> <li>• Describe and exhibit skills needed for effective communication. (FS 2.0; ESLR 1)</li> <li>• Define basic safety rules in the classroom and workplace and be able to follow these rules in the workplace.</li> </ul>					
<p>E. Occupational Safety</p>	<ul style="list-style-type: none"> <li>• Discuss health and safety policies, procedures, regulations, and practices, exhibit the proper use of equipment and handling of hazardous materials (FS 6.0; ESLR 4)</li> <li>• Describe what is necessary to maintain employment. (FS 3.0; ESLR 3)</li> </ul>					

Rev: 1/25/2012

6

<p>F. Employment Literacy</p> <ul style="list-style-type: none"> <li>• Employability Skills</li> <li>• Job Survival Skills</li> <li>• All Aspects of the Industry</li> </ul>	<ul style="list-style-type: none"> <li>• Be able to search for employment, write a resume and cover letter, complete a job application, and participate in a successful interview. (FS 2.2 grades 9-10 (2,5), 2.3 grades 9-10 (1.4), grades 11-12 (1.2); 3.0; CAHSEE L/A W/O 1.0; ELSR 3)</li> <li>• Describe and design a delivery system, the major components of a system and how external factors can affect a system (HS: FS 10.0; ESLR 2)</li> </ul>					
<p>G. Technology Literacy</p>	<ul style="list-style-type: none"> <li>• Use technological resources to access, manipulate, and produce information, products and services. (Address in specific modules) (FS 4.0; ESLR 2)</li> </ul>					
<p>H. Exit Activities</p>	<ul style="list-style-type: none"> <li>• Successful completion of all course work, course evaluation opportunity for feedback. (FS 11.0)</li> </ul>					

Career Technical Education: Engineering and Design Foundation Standards (FS) and Pathway Standards: Environmental and Natural Science Engineering Pathway Standards (PS)  
 Expected Student Learning Results – ESLRS (1) Communicating Effectively; (2) Accessing and Managing Job Related Resources; (3) Setting Career and Life Goals; (4) Accepting Personal Responsibility California High School Exit Exam – CAHSEE: Language Arts (L/A), Writing (W), Written and Oral English Language Conventions (W/O), Listening & Speaking (L/S);  
 Mathematics (M), Number Sense (NS), Measurement & Geometry (MG), Mathematical Reasoning (MR), Statistics (S), Algebra (A), Algebra I (AI)

INSTRUCTIONAL CONTENT	STUDENT OUTCOMES	C	CC		CVE	
			R I	OJT	RI	OJT
<b>II. PROJECT MANAGEMENT</b>		12				
<p>A. Project Development</p> <ul style="list-style-type: none"> <li>• Initiation</li> <li>• Planning</li> <li>• Execution</li> <li>• Monitoring</li> <li>• Controlling and Closing</li> </ul> <p>B. Project Initiation</p> <ul style="list-style-type: none"> <li>• Purpose</li> <li>• Objectives</li> <li>• Success criteria</li> <li>• Deliverables</li> <li>• Assumptions</li> <li>• Dependencies</li> <li>• Constraints</li> <li>• Roles and Responsibilities</li> </ul> <p>C. Project Planning</p> <ul style="list-style-type: none"> <li>• Start-up Plan</li> <li>• Work Plan</li> <li>• Control Plan</li> </ul> <p>D. Project Execution</p> <ul style="list-style-type: none"> <li>• Documenting Milestones</li> <li>• Collecting Metrics</li> <li>• Developing a Risk Management Plan</li> <li>• Issue Resolution Plan</li> </ul> <p>E. Monitoring and Controlling</p> <ul style="list-style-type: none"> <li>• Gantt Charts</li> <li>• Work Breakdown Structures</li> <li>• Monitor Project Timelines and Milestones</li> </ul> <p>F. Closing</p> <ul style="list-style-type: none"> <li>• Projects Submitted: <ul style="list-style-type: none"> <li>◦ On Time</li> <li>◦ Within Budget</li> <li>◦ Project Analysis and Evaluation</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Identify and define the steps used in project management. (PS 5.1-3)</li> </ul> <ul style="list-style-type: none"> <li>• Identify and apply group brainstorming techniques and the rules associated with brainstorming to initiate project. (FS 9.1, 9.7; PS 5.2)</li> <li>• Outline components of a project in a project management plan. (FS 9.1, 9.3, 9.6; PS 5.1-3)</li> <li>• Define team roles and responsibilities. (FS 9.1, 9.3, 9.6)</li> <li>• Explain why teams of people are used to solve problems. (FS 9.1, 9.3, 9.6; PS 5.1-3)</li> </ul> <ul style="list-style-type: none"> <li>• Use MS Project to create timeline and management project. (FS 1.a; PS 5.1-3)</li> </ul> <ul style="list-style-type: none"> <li>• Identify risks, list mitigation strategies. (PS 5.1-3, 5.5)</li> <li>• Identify strategies for addressing and solving conflicts that occur between team members. (FS 9.4, 9.5).</li> </ul> <ul style="list-style-type: none"> <li>• Create Gantt charts and work breakdown structures to monitor progress and timelines. (FS 1.a)</li> </ul> <ul style="list-style-type: none"> <li>• Submit project on time and within specified guidelines.</li> <li>• Present a project in the form of a poster or paper to an audience (FS 2.3, 2.6)</li> </ul>					

Career Technical Education: Engineering and Design Foundation Standards (FS) and Pathway Standards: Environmental and Natural Science Engineering Pathway Standards (PS)

Expected Student Learning Results – ESLRS (1) Communicating Effectively; (2) Accessing and Managing Job Related Resources; (3) Setting Career and Life Goals; (4) Accepting Personal Responsibility California High School Exit Exam – CAHSEE: Language Arts (L/A), Writing (W), Written and Oral English Language Conventions (W/O), Listening & Speaking (L/S);

Mathematics (M), Number Sense (NS), Measurement & Geometry (MG), Mathematical Reasoning (MR), Statistics (S), Algebra (A), Algebra I (AI)

Rev: 1/25/2012

8

INSTRUCTIONAL CONTENT	STUDENT OUTCOMES	C	CC		CVE	
			RI	OJT	RI	OJT
<b>III. RESEARCH DESIGN</b>		12				
A. Forming a Hypothesis <ul style="list-style-type: none"> <li>Identify the Problem or Question to be Investigated</li> </ul>	<ul style="list-style-type: none"> <li>Formulate a testable hypothesis.</li> </ul>					
B. Observational Studies <ul style="list-style-type: none"> <li>Test a Hypothesis</li> <li>Data Collection Qualitative or Quantitative</li> </ul>	<ul style="list-style-type: none"> <li>Create a data dictionary in Pathfinder Office or ArcPad to collect and record data. (FS 1.a; PS 8.1, 8.2, 9.1-3)</li> </ul>					
C. Experimental Studies <ul style="list-style-type: none"> <li>Independent Variable</li> <li>Dependent Variable</li> <li>Control</li> <li>Data Collection Can be Qualitative or Quantitative</li> <li>Computer Modeling</li> </ul>	<ul style="list-style-type: none"> <li>Any experimental studies that students perform will have the prior approval of an independent research board.</li> <li>Use the model builder tool in ArcGIS to model variables affecting a study. (PS 8.4, 9.3)</li> </ul>					

Career Technical Education: Engineering and Design Foundation Standards (FS) and Pathway Standards: Environmental and Natural Science Engineering Pathway Standards (PS)  
Expected Student Learning Results – ESLRS (1) Communicating Effectively; (2) Accessing and Managing Job Related Resources; (3) Setting Career and Life Goals; (4) Accepting Personal Responsibility California High School Exit Exam – CAHSEE: Language Arts (L/A), Writing (W), Written and Oral English Language Conventions (W/O), Listening & Speaking (L/S);  
Mathematics (M), Number Sense (NS), Measurement & Geometry (MG), Mathematical Reasoning (MR), Statistics (S), Algebra (A), Algebra I (AI)

Rev: 1/25/2012

9

INSTRUCTIONAL CONTENT	STUDENT OUTCOMES	C	CC		CVE	
			R I	OJT	RI	OJT
<b>IV. DATA COLLECTION</b>  A. Data Collection <ul style="list-style-type: none"> <li>• Spreadsheet</li> <li>• Teams Communication</li> </ul>	<ul style="list-style-type: none"> <li>• Access publicly available data and organize into spreadsheets. (FS 1.a; PS 8.1, 9.3)</li> <li>• Create Excel spreadsheets (FS 1.a; PS 8.1)</li> <li>• Create comma separated values file. (FS 1.a; PS 8.1)</li> <li>• Collect spatial and ecological and biological data in the field. (FS 1.a; PS 8.1-3, 9.1-3)</li> <li>• Record field data into data dictionary. (FS 1.a; PS 8.1-3)</li> <li>• Document data collection with geotagged photographs. (FS 1.a; PS 8, 9.1)</li> <li>• Add field data into GIS map. (FS 1.a; PS 8, 9.1)</li> <li>• Add photos into GIS map. (FS 1.a; PS 8, 9.1)</li> <li>• Add caption for photograph in map with a text box. (FS 1.a; PS 8, 9.1)</li> </ul>	24				

Career Technical Education: Engineering and Design Foundation Standards (FS) and Pathway Standards: Environmental and Natural Science Engineering Pathway Standards (PS)  
 Expected Student Learning Results – ESLRS (1) Communicating Effectively; (2) Accessing and Managing Job Related Resources; (3) Setting Career and Life Goals; (4) Accepting Personal Responsibility California High School Exit Exam – CAHSEE: Language Arts (L/A), Writing (W), Written and Oral English Language Conventions (W/O), Listening & Speaking (L/S);  
 Mathematics (M), Number Sense (NS), Measurement & Geometry (MG), Mathematical Reasoning (MR), Statistics (S), Algebra (A), Algebra I (AI)

INSTRUCTIONAL CONTENT	STUDENT OUTCOMES	C	CC		CVE	
			R I	OJT	RI	OJT
<b>V. GIS APPLICATION AND ANALYSIS</b>		70				
A. Using the ArcGIS Standard Toolbar <ul style="list-style-type: none"> <li>• Navigate Through a Map</li> <li>• Modify Map</li> <li>• ArcCatalog</li> <li>• Additional Toolbars</li> </ul>	<ul style="list-style-type: none"> <li>• Use basic features of ArcGIS menu options and standard toolbar to create a map document. (FS 1.a; PS 2.4, 5.1, 8.1)</li> </ul>					
B. Creating a Reference Map <ul style="list-style-type: none"> <li>• Illustrate Geographic Boundaries for Cities, Counties and Other Areas</li> </ul>	<ul style="list-style-type: none"> <li>• Apply fundamental GIS skills to document a study area. (FS 1.a; PS 2.4, 5.1, 5.2, 8.2)</li> <li>• Create a map layout with seven essential elements. (FS 1.a; PS 2.4, 5.1, 5.2, 8.1)</li> <li>• Export map. (FS 1.a; PS 5.1, 8.1)</li> <li>• Create a map book. (FS 1.a; PS 2.4, 5.1, 5.2, 8.1)</li> <li>• Create a geodatabase. (FS 1.a; PS 5.2, 8.1)</li> </ul>					
C. Using the ArcGIS Standard Toolbar <ul style="list-style-type: none"> <li>• Navigate Through a Map</li> <li>• Modify Map</li> <li>• ArcCatalog</li> <li>• Additional Toolbars</li> </ul>	<ul style="list-style-type: none"> <li>• Use basic features of ArcGIS menu options and standard toolbar to create a map document. (FS 1.a; PS 2.4, 5.1, 8.1)</li> </ul>					
D. Creating a Reference Map <ul style="list-style-type: none"> <li>• Illustrate Geographic Boundaries for Cities, Counties and Other Areas</li> </ul>	<ul style="list-style-type: none"> <li>• Apply fundamental GIS skills to document a study area. (FS 1.a; PS 2.4, 5.1, 5.2, 8.2)</li> <li>• Create a map layout with seven essential elements. (FS 1.a; PS 2.4, 5.1, 5.2, 8.1)</li> <li>• Export map. (FS 1.a; PS 5.1, 8.1)</li> <li>• Create a map book. (FS 1.a; PS 2.4, 5.1, 5.2, 8.1)</li> <li>• Create a geodatabase. (FS 1.a; PS 5.2, 8.1)</li> </ul>					
E. Projecting Shapefiles <ul style="list-style-type: none"> <li>• Projections</li> <li>• Datums</li> <li>• Coordinate Systems</li> </ul>	<ul style="list-style-type: none"> <li>• Define a datum. (FS 1.a)</li> <li>• Define the projected coordinate system. (FS 1.a)</li> </ul>					

Career Technical Education: Engineering and Design Foundation Standards (FS) and Pathway Standards: Environmental and Natural Science Engineering Pathway Standards (PS)  
Expected Student Learning Results – ESLRS (1) Communicating Effectively; (2) Accessing and Managing Job Related Resources; (3) Setting Career and Life Goals; (4) Accepting Personal Responsibility California High School Exit Exam – CAHSEE: Language Arts (L/A), Writing (W), Written and Oral English Language Conventions (W/O), Listening & Speaking (L/S);  
Mathematics (M), Number Sense (NS), Measurement & Geometry (MG), Mathematical Reasoning (MR), Statistics (S), Algebra (A), Algebra I (AI)

Rev: 1/25/2012

11

INSTRUCTIONAL CONTENT	STUDENT OUTCOMES	C	CC		CVE	
		RI	OJT	RI	OJT	
<p>F. Joining Data to Maps</p> <ul style="list-style-type: none"> <li>• Spreadsheets</li> <li>• Joins</li> <li>• Relates</li> </ul> <p>G. Creating a Thematic Map</p> <ul style="list-style-type: none"> <li>• Mapping Thematically</li> </ul> <p>H. Edit an Attribute Table</p> <ul style="list-style-type: none"> <li>• Add Columns</li> <li>• Delete Columns</li> <li>• Edit Values</li> <li>• Perform Calculations</li> </ul> <p>I. Address Mapping</p> <ul style="list-style-type: none"> <li>• Geocoding</li> </ul> <p>J. GPS Point Mapping</p> <ul style="list-style-type: none"> <li>• Map Latitude and Longitude Data Points</li> </ul> <p>K. Edit Boundaries</p> <ul style="list-style-type: none"> <li>• Polygon Boundaries</li> </ul> <p>L. Spatial Join</p> <ul style="list-style-type: none"> <li>• Join shapefiles</li> </ul> <p>M. Georeferencing</p> <ul style="list-style-type: none"> <li>• Assign Spatial Coordinates to Raster Maps</li> </ul> <p>N. Attribute Query</p> <ul style="list-style-type: none"> <li>• Select Geographies Within Other Geographies</li> </ul>	<ul style="list-style-type: none"> <li>• Join a spreadsheet to a shapefile for data visualization. (FS 1.a; PS 8.1)</li> <li>• Export data and add to map as a new layer. (FS 1.a; PS 8.1)</li> <li>• Use symbology to display a map theme. (FS 1.a, 5.1-3; PS 9.1-3)</li> <li>• Use editing functions to make changes to an attribute table. (FS 1.a, 5.1-3; PS 9.1-3)</li> <li>• Geocode addresses to map features. (FS 1.a, 5.1-3)</li> <li>• Use XY data from spreadsheet to create layers and shapefiles. (FS 1.a, 5.1-3; PS 9.1-3)</li> <li>• Use editing and geoprocessing tools to change polygon boundaries. (FS 1.a, 5.1-3; PS 9.1-3)</li> <li>• Join boundaries and attributes of two shapefiles. (FS 1.a, 5.1-3; PS 9.1-3)</li> <li>• Georeference aerial imagery. (FS 1.a; PS 9.1-3)</li> <li>• Digitize a paper map. (FS 1.a; PS 9.2-3)</li> <li>• Query data by attribute and location. (FS 1.a, 5.1-3; PS 8.1, 8.2, 9.1-3)</li> <li>• Export data and add to map as a new layer. (FS 1.a; PS 8.1)</li> </ul>					

Rev: 1/25/2012

12



<p>O. ArcGIS Extensions</p> <ul style="list-style-type: none"> <li>• Spatial Analyst</li> <li>• 3D Analyst</li> <li>• Geostatistical Analyst</li> </ul>	<ul style="list-style-type: none"> <li>• Identify and effectively use extensions that will be useful in data analysis for a given project. (FS 1.a; PS 5.2-3, 9.1-3)</li> <li>• Use statistical tools to analyze data. (FS 1.a; PS 5.2-4, 9.1-3)</li> <li>• Employ geovisualization techniques in data analysis. (FS 1.a; PS 5.1-3, 9.1-3)</li> <li>• Recognize there are 3<sup>rd</sup> party software extensions that work with ArcGIS for specific project objectives. (FS 1.a; PS 5.1, 9.1)</li> <li>• Understand how CAD drawings can be analyzed in ArcGIS. (FS 1.a; PS 9.1-3)</li> </ul>					
---	---	--	--	--	--	--

Career Technical Education: Engineering and Design Foundation Standards (FS) and Pathway Standards: Environmental and Natural Science Engineering Pathway Standards (PS)  
 Expected Student Learning Results – ESLRS (1) Communicating Effectively; (2) Accessing and Managing Job Related Resources; (3) Setting Career and Life Goals; (4) Accepting Personal Responsibility California High School Exit Exam – CAHSEE: Language Arts (L/A), Writing (W), Written and Oral English Language Conventions (W/O), Listening & Speaking (L/S);  
 Mathematics (M), Number Sense (NS), Measurement & Geometry (MG), Mathematical Reasoning (MR), Statistics (S), Algebra (A), Algebra I (AI)

INSTRUCTIONAL CONTENT	STUDENT OUTCOMES	C	CC		CVE	
		RI	OJT	RI	OJT	
<b>VI. COMMUNICATE RESULTS</b>		50				
<p>A. Cartography</p> <ul style="list-style-type: none"> <li>• Essential Map Elements</li> <li>• Colors</li> <li>• Fonts</li> <li>• Sizing</li> </ul>	<ul style="list-style-type: none"> <li>• Use layout view to create maps with the seven essential elements and export as a PDF file. (FS 1.a; 2.3, 2.4, 2.6)</li> </ul>					
<p>B. Results Based Paper</p> <ul style="list-style-type: none"> <li>• Written Summaries and Reports</li> <li>• Publications</li> <li>• Scientific Method Formatted Paper</li> <li>• Peer Review</li> </ul>	<ul style="list-style-type: none"> <li>• Write and submit a summary project report. (FS 2.2, 2.3 a-d)</li> <li>• Write a scientific paper to communicate findings of a study with all standard scientific components. (FS 2.2, 2.3 a-d)</li> <li>Use internet resources, such as email, and Google Docs to communicate with a peer team to edit a paper. (FS 2.2, 2.3 a-d)</li> </ul>					
<p>C. Graphic Illustration</p> <ul style="list-style-type: none"> <li>• Cartographic Principles</li> <li>• Map Design</li> <li>• Poster Displays</li> <li>• Scientific Poster</li> </ul>	<ul style="list-style-type: none"> <li>• Design a poster in Photoshop that illustrates a research project. (FS 1.a, 2.4 a-d)</li> <li>• Explain what aesthetics is, and how it contributes to a poster design's success.</li> <li>• Identify visual design principles and elements that are present within scientific posters. (FS 2.3 a-d, 2.6 a-d)</li> </ul>					
<p>D. Presentation</p> <ul style="list-style-type: none"> <li>• Poster Symposiums</li> <li>• Platform Presentations</li> <li>• PowerPoint Presentations</li> </ul>	<ul style="list-style-type: none"> <li>• Participate in a poster symposium to communicate research findings. (FS 2.2-4)</li> <li>• Create a PowerPoint presentation following specified guidelines to communicate research findings. (FS 1.6-8, 2.2 a-f, 2.5 a-d, 2.6 a-d)</li> </ul>					

Career Technical Education: Engineering and Design Foundation Standards (FS) and Pathway Standards: Environmental and Natural Science Engineering Pathway Standards (PS)  
 Expected Student Learning Results – ESLRS (1) Communicating Effectively; (2) Accessing and Managing Job Related Resources; (3) Setting Career and Life Goals; (4) Accepting Personal Responsibility California High School Exit Exam – CAHSEE: Language Arts (L/A), Writing (W), Written and Oral English Language Conventions (W/O), Listening & Speaking (L/S);  
 Mathematics (M), Number Sense (NS), Measurement & Geometry (MG), Mathematical Reasoning (MR), Statistics (S), Algebra (A), Algebra I (AI)

Rev: 1/25/2012

14

INSTRUCTIONAL CONTENT	STUDENT OUTCOMES	C	CC		CVE	
			RI	OJT	RI	OJT
I. Career Essentials		12				
II. Project Management		12				
III. Research Design		12				
IV. Data Collection		24				
V. GIS Applications and Analysis		70				
VI. Communicating Results		50				
	Total Classroom Hours =	180				
	Total CC Related Instruction Hours =					
	Total CC Hours =					
	Total CVE Related Instruction Hours =					
	Total CVE OJT Hours =					
	<b>TOTAL COURSE HOURS = 187</b>	<b>180</b>				

## Expected Student Learning Results

**Every ROP student will be a life-long learner and will apply professional and technical skills for successful employment by:**

### **Communicating Effectively**

Students understand, create, manage, and deliver effective oral, written and multimedia communication in a variety of formats and contexts. *(CTE Foundation Standard 2.0 Communication)*

- Using professional language and workplace terminology
- Demonstrating effective listening skills
- Generating clear and purposeful written documents
- Delivering a variety of oral presentations

Students understand effective leadership styles, key concepts of group dynamics, team and individual decision-making, the benefits of workforce diversity, and conflict resolution. *(CTE Foundation Standard 9.0 Leadership and Teamwork)*

- Participating as a member of a team
- Working with diversity
- Demonstrating negotiation skills

### **Accessing and Managing Job Related Resources**

Students know how to use contemporary and emerging technological resources in diverse and changing personal, community and workplace environments. *(CTE Foundation Standard 4.0 Technology)*

- Selecting and applying appropriate supplies, resources, and technology to the task
- Identifying the similarities and differences within all aspects of the industry

Students understand how to create alternative solutions by using critical and creative thinking skills, such as logical reasoning, analytical thinking, and problem-solving techniques. *(CTE Foundation Standard 5.0 Problem Solving and Critical Thinking)*

- Organizing and managing time on a variety projects and tasks
- Using basic concepts of budgeting and financial management
- Applying critical thinking skills to make informed decisions and solve problems

Students understand professional, ethical, and legal behavior consistent with applicable laws, regulations and organizational norms. *(CTE Foundation Standard 8.0 Ethics and Legal Responsibilities)*

- Demonstrating personal integrity, ethical behavior, and social responsibility in the workplace
- Identifying employee/employer rights and responsibilities

### **Setting Career and Life Goals**

Students understand how to make effective decisions, use career information, and manage personal career plans. *(CTE Foundation Standard 3.0 Career Planning and Management)*

- Completing a resume, job application, and simulated job interview
- Planning and researching career interests
- Assessing personal strengths and weaknesses
- Setting short and long-term goals

### **Accepting Personal Responsibility**

Students understand health and safety policies, procedures, regulations and practices, including equipment and hazardous material handling. *(CTE Foundation Standard 6.0 Health and Safety)*

- Practicing job safety
- Passing a safety test

Students know the behaviors associated with the demonstration of responsibility and flexibility in personal, workplace, and community settings. *(CTE Foundation Standard 7.0 Responsibility and Flexibility)*

- Demonstrating punctuality and expected attendance
- Accepting personal responsibility for one's actions
- Demonstrating appropriate coping skills, self discipline, and positive attitudes
- Using workplace etiquette
- Dressing appropriately for the workplace
- Serving clients/customers

Los Angeles County Regional Occupational Program  
**ESLR SCORING GUIDE**

	<b>Communicating Effectively</b>	<b>Accessing and Managing Job Related Resources</b>	<b>Setting Career and Life Goals</b>	<b>Accepting Personal Responsibility</b>
<b>ADVANCED</b>	Always articulates appropriate terminology associated with the subject matter. Consistently summarizes a message in writing or orally. Creates written documents such as letters, directions, manuals, reports, graphs and charts with no grammatical errors. Delivers a clear message that is engaging with appropriate verbal and non-verbal communication. Assumes leadership role on a team. Respects the differences and roles of others. Applies the steps in conflict resolution in a real life situation.	Uses and applies the most appropriate supplies, resources, and technology required to complete a specific task. Consistently demonstrates successful time management strategies to complete assigned tasks. Utilizes comprehensive problem solving skills. Can debate and defend the moral and ethical issues of a situation. Identifies employee/employer rights within a given scenario. Has accurately completed a detailed resume, job application, job interview, and portfolio.	Sets ambitious and realistic career and personal goals; utilizes strategies appropriate for study/work habits, time/organizational management; consistently exhibits initiative, self-discipline, and reflection in academic/personal areas; understands and accepts consequences related to actions.	Mastered entry-level skills, has a 'model' Personal Career Portfolio; exceeds standards in job safety; has excellent attendance and punctuality; maintains a professional appearance and demeanor; trains others and encourages contributions; excels in customer relations; exhibits high moral and ethical behavior; utilizes comprehensive problem solving skills.
<b>PROFICIENT</b>	Usually articulates appropriate terminology associated with the subject matter. Accurately summarizes a message in writing or orally. Creates written documents such as letters, directions, manuals, reports, graphs and charts with few grammatical errors. Delivers a clear message with evidence of purpose. Participates as a responsible and productive team member. Recognizes the differences and roles of others. Identifies steps in conflict resolution.	Identifies and explains the most appropriate supplies, resources, and technology required to complete a specific task. Utilizes time management strategies appropriate to completed assigned tasks. Demonstrates some problem solving skills. Participates in a discussion on moral and ethical issues. Explains in own words basic employee/employer rights. Has accurately completed a resume, job application and a simulated job interview.	Sets realistic and obtainable career and personal goals; recognizes strategies appropriate for study/work habits, time/organizational management; exhibits some initiative and self-discipline in academic/personal areas; understands the consequences related to actions.	Has a complete and approved Personal Career Portfolio; competent in entry-level skills and job safety; meets industry standard for attendance, punctuality and dress; successful employability skills through simulation/actual hiring; understands moral and ethical issues; trains others and assists customers; demonstrates some problem solving skills.
<b>DEVELOPING</b>	Rarely articulates appropriate terminology associated with the subject matter. Inconsistently summarizes a message in writing or orally. Creates written documents such as letters, directions, manuals, reports, graphs and charts with more than 3 grammatical errors. Delivers an unclear message with little or no evidence of purpose. Demonstrates resistance to group work and participation is inconsistent. Limited awareness of the differences and roles of others. Learns the steps in conflict resolution.	Identifies some supplies, resources, and technology required to complete a specific task. Identifies time management strategies to complete assigned tasks. Can explain the steps in problem solving. Can define terms "moral" and "ethical." Introduced to basic employee/employer rights. Resume completed with errors. Less than adequately prepared or no job interview.	Able to establish some personal and career goals; lists strategies appropriate for study/work habits, time/organizational management; occasionally demonstrates initiative or self-discipline; has some difficulty in accepting consequences related to actions.	Has started Personal Career Portfolio; requires reinforcement of safety standards; attendance is below d; practicing appropriate dress standard; shows beginning awareness of moral and ethical issues; requires guidance/support in training and assisting customers; can explain the problem solving process.

APPENDIX E: UC “A-G” COURSE OUTLINE GOD

UC Doorways Online Update Template

- **Course Description**

Course Title: The Geology of Disasters: a Hazus-MH Training Course

Subject Area and Category: “g” – Elective: Science-Physical

Grade Level: 10-12

Unit Value: 1.0 (one year, 2 semesters, or 3 trimesters equiv.)

---

- **Course Attributes**

Is this course classified as a Career Technical Education course? Yes

Industry Sector: Engineering and Design

Career Pathway: Environment and Natural Science Engineering

---

- **Catalog Description**

Brief Course Description: *Briefly (in a short paragraph) describe the course, focusing on content, rather than instructional strategies, assessments, or rationale. If school has a catalog, enter the description that is in the catalog.*

The Geology of Disasters; a Hazus-MH Training Course is appropriate for 10<sup>th</sup> through 12<sup>th</sup> grade students who are interested in disaster preparedness planning and mitigation with geographic information systems. The major focus of the Geology of Disasters course is to prepare students to do risk analysis, loss estimation and evaluate mitigation techniques for earthquake, flood and hurricane wind disasters.

Students will employ GIS analysis integrated with cartographic and scientific concepts for the investigation of disaster related problems. Students will develop problem-solving skills and apply their knowledge of research and design to create solutions to various challenges throughout the course. Students will also learn how to document their work, and communicate their findings to their peers and members of the professional community.

Pre-Requisites: Physics

Co-Requisites: Algebra I or Algebra A/ B

- **Background Information**

Context for Course:

The Geology of Disasters: a Hazus-MH Training Course is one of three classes offered as part of a geographic information science program, all of which are approved through the Los Angeles County Regional Occupation Program. This course is not intended to replace a core science class, but is offered as a supplemental science elective. GIS can be used to compliment any college major or career path. Labor market analysis show jobs involving GIS as having high growth potential in the near future.

History of Course Development

This course was developed with the support of a UCLA *Teacher Initiated Inquiry Project* grant awarded to a team from Clark Magnet High School. This team was led by science teacher Dominique Evans-Bye and consisted of three teachers and the head counselor. Ms. Evans-Bye and team member Alex Day-Blattner attended the University of California Curriculum Integration Institute in May of 2011 in order to develop an academically rigorous course integrating career technical education. A partnership with the Federal Emergency Management Agency was fostered resulting in adoption of FEMA training materials for the Hazus-MH portion of the course.

- **Textbooks**

Title Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes Edition: (3rd Edition)

Publication Date: January 16, 2011

Publisher: Prentice Hall

Author(s): Edward A. Keller, Duane E. DeVecchio

Usage: Primary Text



## Supplemental Instructional Materials

Laboratory Manual in Physical Geology

Eighth Edition, Pearson/Prentice Hall

Richard M. Busch, Editor

URL Resource(s):

Natural Hazards: [www.hazardcity.com](http://www.hazardcity.com)

USGS website [www.usgs.gov](http://www.usgs.gov)

FEMA website [www.fema.gov](http://www.fema.gov)

IRIS Incorporated Research Institutions for Seismology <http://www.iris.edu>

NASA website [www.nasa.gov](http://www.nasa.gov)

National Oceanic and Atmospheric Administration website [www.noaa.gov](http://www.noaa.gov)

Pierce College Weather Station <http://www.piercecollegeweather.com/temperatures.html>

FEMA workbooks for Hazus-MH course sections:

313 Basic Hazus-MH

174 Hazus-MH for Earthquake

172 Hazus-MH for Flood

• **Course Content**

**Course Purpose:** *What is the purpose of this course? Please provide a brief description of the goals and expected outcomes. (How these will be accomplished should be reserved for the Course Outline, Key and Written assignments, Assessments, and/or Instructional Methods.)*

**Course Goals and/or Major Student Outcomes**

1. Students demonstrate understanding of geologic features and processes of the Earth – rocks and minerals, geologic formations and changes, the atmosphere, the oceans, the weather and geographical formations, sufficient for college matriculation requirements.
2. Students develop critical thinking, problem solving, and analysis skills as they apply Earth Science knowledge to understanding, mapping, and estimating risk from natural disasters.
3. Students create and run probabilistic and historical hazard scenarios from earthquakes, flood and hurricane winds using Hazus-MH.
4. Students analyze hazard scenario results in terms of loss estimations and loss mitigation strategies using Hazus-MH.
5. Students assess risk and investigate disaster preparedness plans at the site, city, county and state level by combining Hazus-MH analysis and outside research.
6. Students work in teams to prepare a formal risk assessment. This technical document will include Hazus-MH estimates of physical, economic and social impacts from natural disasters along with suggested mitigation strategies.
7. Students prepare a formal presentation for “government officials.”

**Course Outline:** *A detailed descriptive summary of all topics covered. All historical knowledge is expected to be empirically based, give examples. Show examples of how the text is incorporated into the topics covered. A mere listing of topics in outline form is not sufficient (i.e. textbook table of contents or California State Standards).*

**Unit 1 – Is There a Map for That? - Introduction to GIS and the Geology of Earthquakes**

Essential Questions: What is GIS and how am I already using it? What can maps do and how can we use them? How do maps help us understand earthquakes? What are the effects of earthquake hazards on California’s natural resources? How can I apply my understanding of earthquakes and maps to help my family be better prepared for the next earthquake?

In this unit students learn to use maps to connect earthquake hazards to plate tectonics and locations of natural resources in California. They explain how earthquakes occur and recognize signs of tectonic

activity in the world around them and relate the observed properties of rocks to processes that produce rocks, including formulating proposed geologic histories for rocks and possible future changes. Students apply the scales used to measure earthquake intensity and magnitude to assess possible damage from predicted earthquakes on their own home and school.

“a-g” Academic Topics	CTE
Students recognize maps in daily use and categorize their purposes.	Students recognize geographic reference tags in daily use in order to construct what GIS is and predict what it can be used for.
Using posted classroom evacuation maps, students evacuate to designated safe zones and connect the two dimensional representation of space (x,y coordinates) on the maps to real three dimensional space.	Students make 2D to 3D spatial connections.
<p>After trying out the posted evacuation maps, students discuss and develop possible improvements to them. If appropriate students justify to the school administration the need to revise the posted evacuation maps before the Great American Shakeout Drill (November).</p> <p>Students read “Introduction to Natural Hazards “ (Chapter 1, Keller) as a basis for discussion about and identification of key terms employed by professionals in the fields of forecasting, predicting, and providing warnings of hazardous events.</p>	Students select and use suitable software to upgrade posted classroom evacuation maps.

<p>Students list reasons for classroom evacuation maps and procedures and then review published geologic hazard maps of California. They categorize the California hazards and relate hazards to regions of the state. They compare these categories to hazards around the United States and the world to illustrate plate tectonic processes.</p> <p>Students interpret hazard maps to identify evidence of geologic events of the past and predict geologic changes in the future. Students repeat this analysis of published maps in order to identify, categorize and locate California's natural resources, then research how earthquakes and plate tectonic activity are related to the production of the natural resources in the first place.</p>	<p>Students access online hazard maps and related resources.</p>
<p>During a field trip to the San Andreas fault in Palmdale students record observations of evidence of geologic events in the past (folding, sedimentary layers, igneous intrusions, erosion, sag pond) and interpret their observations based on the properties of rocks and the physical and chemical conditions in which they formed, including plate tectonic processes. They use the knowledge, observations and experience to create and publish a class map of the area including detailed, geologically precise descriptions of geologic features and processes.</p> <p>Students connect the observations made during the Palmdale field trip to the principal structures that form at a transform (right lateral strike slip) plate boundary. They classify the three main plate boundaries (convergent, divergent and transform) and identify the principal structures that form at the different boundaries.</p> <p>Students extend their observations and data collecting about rocks from the Palmdale field trip to investigate and identify the properties of sedimentary, igneous, and metamorphic rocks. They connect the properties of rocks to the physical and chemical conditions under which they form by researching those conditions and describe the processes involved.</p>	<p>Students learn GIS coordinate systems and apply that knowledge to map a sag pond. They will use photographs and descriptions of features to develop a map project around geologic features in their community.</p>
<p>Students locate information in the media about recent earthquake activity and summarize the information presented about these events. They</p>	<p>Students will use hand-held GPS units to monitor satellites positions to plan data collection sessions. They will use GPS to</p>

<p>explain why these earthquakes occurred and interpret the modified Mercalli scale for intensity of an earthquake and the Richter scale for the magnitude of an earthquake.</p> <p>Students understand how the epicenter of an earthquake is determined using distance data from a minimum of three seismic observation stations and relate that process to how GPS coordinates are generated using data from a minimum of three satellites. They analyze media reports to connect earthquake events to their effects including structure collapses, fire, landslides, liquefaction, permanent displacement of land surface and tsunamis.</p> <p>Students determine connections between building codes and land use and effects of earthquakes. They then assess the possible effects of earthquakes of particular magnitude or intensities on their home and design a suitable safety plan and earthquake kit for their family.</p> <p>Students discuss provisions made for earthquakes at school, evaluate whether they are sufficient, refine the plan and present their findings to the school's administration.</p> <p>Students use the Hazard City online assignment in applied Geology: Earthquake Damage Assessment, to model possible effects of earthquakes of different intensities on the Modified Mercalli Intensity scale and to scaffold their own analysis of their home and school site.</p> <p>Student readings for this section include "Internal Structure of Earth and Plate Tectonics" "Earthquakes" and "Tsunamis" (Chapter 2, 3 and 4, Keller).</p>	<p>record coordinates of geographic features and input spatial data into GIS maps.</p>
--	--

**Unit 2 - Hazus Earthquake**

Essential Questions: How can Hazus-MH be used to study earthquake hazards in a geographic area? What risks do earthquakes pose for a particular area? How could physical, economic and social impacts be estimated using Hazus-MH? What mitigation strategies would be most effective in reducing damage from earthquakes?

In this unit students learn to use Hazus-MH to create study areas where assessment of risks, estimates of

physical, economic and social impacts and evaluate mitigation strategies for earthquake damage will be performed.

“a-g” Academic Topics	CTE Topics
<p>Students will identify the geologic features and structures that provide evidence of plate tectonics.</p> <p>Students will predict the likelihood of an earthquake in a study area for different magnitudes.</p> <p>Students will evaluate risks posed by earthquakes in California by using United States Geologic Survey shakemaps</p>	<p>Students will create a Hazus earthquake analysis using standard cartographic principles and essential map elements.</p> <p>Students will use global positioning systems equipment to map waypoints of geologic features (anticlines, synclines, tilting and sag ponds) indicating tectonic activity.</p> <p>Students will analyze and list effective options for loss mitigation for earthquake hazards</p> <p>(313 Basic Hazus-MH and 174 Hazus-MH for Earthquake FEMA workbooks)</p>

**Unit 3 – Is There a Map for That? Streams, Floods, and Mass Wasting**

Essential Questions: What are the characteristics of streams and their floods? What are the consequences of floods and what can we do to mitigate those effects?

This unit allows students to define basic river processes, including flooding and the differences between flash floods and downstream floods. They then recognize factors that result in regions being at risk from flooding and summarize the effects of flooding including connections to other hazards and the benefits of flooding. Students outline adjustments that humans can make to reduce flood damage and loss of life. Students describe slopes and the forces acting on them in order to understand what makes a slope unstable. They describe geographic regions at risk from landslides and the links to other hazards. Students assess the impacts human activity have on the probability of a landslide and recommend methods for reducing the probability.

“a-g” Academic Topics	CTE Topics
<p>Students label features of topographic maps and relate them to real-life features to make connections between the two-dimensional representations of three-dimensional objects.</p>	<p>Students create map layout using industry standards.</p>
<p>Students explain the hydrologic cycle in terms of the interrelationship of the hydrosphere, geosphere, biosphere and atmosphere.</p>	<p>Students document the effect human activity has on the environment.</p>

<p>Students map the drainage basin in the area around the school and prepare to educate their peers about water pollution on their school campuses and how to take actions to protect the watershed in order to be ready to enter the Generation Earth “From the Streets to the Sea” competition in April.</p>	<p>Students investigate connections between local watersheds and the ocean.</p> <p>Students diagram ways in which the health of the marine environment affects climate.</p>
<p>Students view world topographic maps in order to recognize and classify drainage patterns, factors affecting stream erosion and deposition, flood plains, deltas, and stream valley development patterns.</p> <p>Students read “Flooding” (Chapter 6, Keller) and incorporate the information provided about basic river processes, the differences between flash floods and downstream floods, possible benefits of floods, and consequences of human activities on flood magnitudes and frequencies into their analyses of local and world-wide flooding data compiled by the group.</p>	<p>Students will list human activities that affect the atmospheric environment.</p>
<p>Students survey media reports concerning recent and historic floods to collect data on locations, causes, effects and timing of flood events and present their findings to their peers. They compile combined findings in order to outline possible ways to control floods or mitigate damage from flooding. Students complete the Hazard City Assignment in Applied Geology: Flood Insurance Rate Maps to analyze the predicted flood damages to three residential properties in order to recommend to the homeowners how much flood insurance to purchase.</p>	<p>Students access online hazard maps and related resources.</p>
<p>Students review media reports related to the La Conchita landslide of 2005 and read “Mass Wasting” (Chapter 7, Keller) to recognize processes that result in different types of landslides and geographic regions at risk from landslides.</p> <p>Students investigate the effects of forces on slopes and the influence on probability of mass wasting.</p> <p>Students evaluate the effects of landslides and how human activities affect landslides.</p> <p>Students identify features that indicate high potential for landslide in order to propose approaches for minimizing landslide hazards.</p>	<p>Students use GIS to identify areas prone to geological hazards.</p> <p>Students describe processes causing soil erosion.</p>
<p>Students combine their “Streets to the Sea” water pollution data with their knowledge of flood and mass wasting events to report on the probability of a flood event or a landslide occurring on the</p>	

school campus and in the surrounding neighborhood, the possible consequences and possible responses to avoid death and damage.

**Unit 4 - Hazus Flood**

Essential Questions: How does topography influence the path water takes through a study area? How do coastal floods differ from riverine floods? How can Hazus-MH estimate the volume and velocity of running water? What differences exist between 50, 100 and 500 year flood events?

Students will define topography, generate a stream network, define a flood scenario, run hydrology and delineate a floodplain. Students will perform a risk assessment, generate loss estimations and loss mitigation strategies for a flood event.

“a-g” Academic Topics	CTE Topics
<p>Students Compare and contrast riverine verses coastal flood events in California.</p> <p>Students will use digital elevation models from the USGS to identify areas in California susceptible to flooding .</p> <p>Students will then use a depth-damage curve to predict percent loss by flood depth and evaluate mitigation strategies.</p>	<p>Students create a Hazus-MH flood analysis using standard cartographic principles and essential map elements. They will use Hazus-MH to assess the risk for a 100-year and 500-year flood event and estimate associated losses.</p> <p>Students will create a topographical map by Integrating a DEM to determine the direction of water flow through a study area.</p> <p>Students will analyze and list effective options for loss mitigation for flood hazards.</p> <p>(313 Basic Hazus-MH and 172 Hazus-MH for Flood FEMA workbooks)</p>

**Unit 5 – “In Hertford, Hereford and Hampshire, Hurricanes Hardly Ever Happen”**

Essential Questions: What are hurricanes, where do they happen and why? What is the difference between a hurricane and a tornado? What is the difference between weather and climate? What are the effects of other severe weather conditions and how can we minimize these effects?

Through this unit students examine the energy balancing act that produces weather and climate on Earth, and compare and contrast weather and climate in order to be able to distinguish between the two terms. Students outline different types of severe weather events and assess the main effects, including links to other natural hazards, in order to propose approaches to minimizing adverse effects. Students recognize the weather conditions that create, maintain, and dissipate hurricanes, geographic regions at risk and



summarize the effects of hurricanes including associated hazards and benefits. Students communicate actions that minimize damage and injury from hurricanes, and describe actions that would be prudent during hurricane watches and hurricane warnings.

“a-g” Academic Topics	CTE Topics
<p>Students recall meteorological terms associated with Hurricane Katrina and research the damage estimates and current status of rebuilding in New Orleans. They compare and contrast the meteorological terms associated with reports about the April 2011 tornados in Alabama and the damage estimates for those disasters.</p>	<p>Students will use Hazus-MH to analyze atmospheric pressure and weather systems.</p>
<p>Students distinguish between tornadoes and hurricanes by understanding the development and occurrence of tornadoes (including air masses that result in severe thunderstorms) compared to the formation and decay of hurricanes.</p> <p>Students consider lightning casualties in the US and safety guidelines for lightning storms and surviving violent tornadoes. “Atmosphere and Severe Weather” (Chapter 9, Keller).</p>	<p>Students will describe systems used to monitor, analyze and predict conditions of meteorological events.</p>
<p>Students map hurricanes to identify world regions where they occur, categorize principal months for hurricane season, find common hurricane tracks and recognize the band of no hurricanes within five degrees Celsius of the equator. Students will postulate why these patterns occur.</p>	<p>Students Use GIS technology to document, analyze and model storm systems.</p>
<p>Students survey media reports concerning recent and historic hurricanes and complete additional research to ascertain the history of the naming methodology for tropical storms and hurricanes, how the Saffir-Simpson Scale is used, what storm surge is, levels of wind damage from a hurricane, how hurricanes are related to heavy rains and inland flooding, and the difference between hurricane watches and warnings. “Hurricanes and Extratropical Cyclones” (Chapter 10, Keller)</p>	<p>Students use appropriate tools and procedures to analyze historic hurricane scenarios.</p>

**Unit 6 - Hazus Hurricane Winds\***

Essential Questions: What kind of damage do hurricanes cause? How are hurricanes categorized? What historical patterns of hurricanes are recorded? How can Hazus-MH predict the probability of a hurricane occurring in geographic area?

Students create and analyze reports of direct physical, economic and social losses due to the impact of hurricane winds in an area prone to hurricanes. Both historical and probabilistic scenarios will be explored using Hazus-MH.

\*This unit is purposely shortened on the recommendation of the industry steering committee, due to the fact that hurricanes do not occur in California.

“a-g” Academic Topics	CTE Topics
<p>Students will model effect of Hurricane winds transferring energy from the atmosphere into inhabited areas.</p> <p>Students will correlate hurricane risk and proximity to warm water ocean currents.</p>	<p>Students will create a Hazus hurricane analysis using standard cartographic principles and essential map elements.</p> <p>Students analyze and list effective options for loss mitigation for hurricane wind hazards.</p> <p>(313 Basic Hazus-MH FEMA workbook)</p>

**Unit 7 - What a Disaster! Final Project**

Essential Questions: What other natural (or man-made) disasters should we consider when creating local, city, and state emergency preparedness plans? What can communities learn from disasters that happened in the past? How can we communicate important information to our classmates, family members, community members?

Students recall what they have read and written about during the course so far, and analyze the features of a natural disaster compared to a man-made disaster to determine what constitutes a catastrophe. Students document patterns in the data concerning current and historic disaster events and consequences. Students research a particular historic disaster and work in a group to produce a multimedia presentation that includes quantitative data to illustrate and explain the causes and effects of the disaster to a peer group. Students demonstrate knowledge of disaster terminology, mapping techniques and use, human impacts on disasters and approaches to mitigation. Students work in groups to produce an in-depth analysis. The group will manage a timeline to meet deadlines and show appropriate division of labor to accomplish the task. All students will practice presentation skills to peers and will consider the next steps necessary for a presentation to a wider community.

“a-g” Academic Topics	CTE Topics
<p>Students list natural disasters and distinguish them from man-made disasters. Fires (natural and arson), deaths from extremes of temperature (heat and cold), volcanoes, creep, avalanches, subsidence (natural and from mining), water pollution (from mining, oil spills, chemical spills, nuclear leaks).</p> <p>Students select methods for communicating information to different audiences. Re-read “Introduction to Natural Hazards” (Chapter 1, Keller).</p>	
<p>Students select a disaster to research for final group</p>	<p>Students will work as a team to organize</p>

<p>projects and presentations.</p> <p>Students collect information about the disaster and construct a description of that disaster for their class including when, where, why, what and how, the casualties and destruction, responses and long term consequences. Students assess what could have been done differently to mitigate damages or what the response might be if an historic disaster were to strike today.</p> <p>Students begin the research process by reading or rereading chapters from the textbook: “Tsunamis, Volcanoes. Subsidence and Soils, Atmosphere and Severe Weather, Coastal Hazards, Climate and Climate Change, Wildfires” (Chapters 4, 5, 8, 9, 11, 12, and 13, Keller).</p>	<p>a disaster plan for a study site.</p>
<p>Students present findings to classmates and consider possible amendments that would be necessary in order to make presentations suitable for the school community or wider audiences.</p>	<p>Students communicate risk assessment and mitigation strategy results in a PowerPoint presentation.</p>

**Unit 8 – Risk Assessment**

Essential Questions: What are the risks of natural hazards in a geographic area? What potential losses could occur from each type of hazard identified? How can Hazus-MH be used to generate reports that estimate loss from natural disasters? How can mitigation strategies be evaluated for effectiveness in reducing loss with Hazus-MH?

As a working group, students will evaluate all potential risks for a study area of their choosing. They will create and analyze Hazus-MH reports of direct physical, economic and social losses due to the risks identified and include mitigation strategies that have been modeled in Hazus-MH and have shown effectiveness in reducing losses. Students will identify the government officials, emergency management personnel and community members that would need to be assembled as a team to deal with a natural disaster striking a community. Students will use Hazus-MH to prepare technical reports and present as a simulated disaster management team, a full risk assessment of a study area to a community group.

“a-g” Academic Topics	CTE Topics
<p>In a project based learning setting, students will conduct a literature search for all potential geologic hazards that could impact a study area. They will analyze geographic and geologic data to evaluate risks, then create a summative report to communicate the imposed risks and offer solutions to reduce losses.</p>	<p>Students will use project management skills within a team to develop a complete risk assessment for a study area.</p> <p>Students will apply appropriate problem-solving strategies and critical thinking skills to rank hazards for a study area from greatest to lowest risk and form a priority list of mitigation strategies.</p> <p>(296 Application of Hazus-MH for Risk Assessment</p>

	and 317 Comprehensive Data Management FEMA workbooks)
--	---

**Laboratory Activities:** *Acceptable courses include hands-on scientific activities that are directly related to and support the other classwork, and that involve inquiry, observation, analysis, and write-up. These hands-on activities should account for at least 20% of class time, and should be listed and described in detail. Please itemize and describe each laboratory activity in detail.*

Topographic Maps, Aerial Photographs, and Satellite Images (Laboratory Manual in Physical Geology, Laboratory Nine, pages 167 – 194)

Students use map symbols, colors, latitude and longitude, and compass bearings to locate features on topographic maps. Students recognize the scales on topographic maps and use that knowledge to identify the scales of the maps studied and developed in *Unit 1 – Is there a Map for that?* Students discuss the use of maps that are not to scale and possible cautions for such maps for use during disaster events.

Students practice interpreting and constructing contour lines based on points of known elevation on Earth's surface. Students collect data concerning elevation for the school campus and add that to existing campus maps. Students construct topographic profiles and calculate their vertical exaggeration, including for the campus map.

Thinking Science! ([www.undsci.berkeley.edu](http://www.undsci.berkeley.edu))

Students observe what happens when different materials are placed in water using blocks of various materials (including concrete, clay, metal, wood, salt, limestone) and/or objects they provide. Students present their observations to the group and appropriate methods for recording observations for future reference are discussed and agreed upon. Questions about what has been observed are brainstormed and groups assigned to investigate one of the questions further. Groups research existing knowledge using the internet and Chemistry, Physics, and Geology textbooks provided for reference. Students plan and carry out investigations to collect further first hand observations to refute or support their initial questions and possible answers. Students write up their plans, observations and reflections on what they observe in individual science notebooks. The relationship between the density of the blocks as well as their nature can be discussed and drawn out and methods developed for measuring density of materials. Students use the density simulation at <http://phet.colorado.edu/en/simulation/density> to further observe the effects of volume, mass and density on isostatic equilibrium, to record data for analysis, and to consider the use of models in science for furthering understanding.

Observing and Measuring Earth Materials and Processes

Ongoing weather data collection and analysis

Pasco temperature probes will be used to measure soil temperatures at various locations and times on campus. Thermometers will be designated for shade and non-shade temperature readings at various locations and times. Additional observations of cloud cover, wind conditions will be recorded. Students develop original scales for categorizing wind speeds and then research how wind is measured at the local weather stations. Procedures for recording the data collected is to be developed by the students and reflected upon and revised as the volume of data collected increases through the course. Students calculate the average temperatures for a month for a particular location at the school and compare results for different locations and suggest possible explanations for variations in values. Students also compare

an average value at the school site to the monthly averages from the Glendale weather station and the Pierce College (San Fernando Valley) station. Additional data can be collected and analyzed (e.g. develop a rain gauge, a method for estimating percentage cloud coverage) as students demonstrate interest in additional challenges. Relationship between humidity values recorded at weather stations and conditions noticed on campus will be discussed and analyzed.

#### Ongoing disaster data collection

On a world map posted in the classroom, students record with a colored sticker (color coded for severity of disaster according to class agreed parameters) the location of disaster events as they occur and write the date on the sticker. Responsibility for recording events during a particular week assigned to different students each week. An event log to be kept in addition to the map record, in order to provide confirmation for no event days or weeks. Student reporters also post a written summary of an event on the class wiki page including hyperlinks to the news sources referred to for reporting the event. Class members required to comment on event summaries at least once every two weeks. The class generated map can be periodically compared to online versions provided by usgs.gov and IRIS (<http://www.iris.edu/dms/seismon.htm>) and differences noted and possible reasons discussed.

#### Data Collection Field trip to San Andreas Fault and Sag Pond in the Antelope Valley

Before the field trip – students read Laboratory Manual in Physical Geology pages 1-25 about how Geologists observe earth materials and the processes of change through time, including the scales involved in the observations, and the importance of direct observation, investigation, and measurement in the field and in the laboratory, and the use of satellite remote sensing. Students discuss the text in order to answer questions from the lab manual in writing in their lab notebooks about geologic time, and the analysis of satellite images. Students plan what observations they expect to be able to make and record during the field trip. They will determine what equipment/technology to take on the trip and how the items will be used in the field.

During the field trip – Students use Trimble Juno hand-held GPS units to map geologic features such as anticlines, synclines, sag pond and tilting along the fault line. Each feature will also be documented as a GeoTiff photo. Field trip data will be mapped in GIS following the trip.

#### Rock Forming Processes and the Rock Cycle (Laboratory Four, pages 75 - 88)

Students observe a set of numbered rock samples and the photographs collected during the field trip using a magnifying lens. They record rock properties (textures, minerals, fossils) in a table in their lab notebooks and use their observations to infer the rock classification (igneous, sedimentary, metamorphic) and describe how the rock was formed. Additional research and reading to be carried out using the internet and Geology texts as necessary. Students use the rock cycle to propose possible future changes for each rock sample. The website: [www.joidesresolution.org](http://www.joidesresolution.org) is used to track the ongoing work of scientists aboard the ship collecting ocean crust core samples.

#### Earthquake Hazards and Human Risks (Laboratory Sixteen, pages 297 to 300 )

Students experiment with models to make connections between earthquake damage to buildings and the type of ground they are situated on. For buildings built on uncompact dry sediment, participants use a cup of sand with several coins placed vertically to model walls of buildings, tap on table as the cup is rotated to simulate an earthquake. For buildings built on moist compacted sediment, repeat with coins pushed into moist sand that has been pressed down. Students record the results in a lab notebook and write an explanation what might happen to the compacted moist sediment if it became totally saturated with water and an earthquake occurred. Students will design a follow up model to test the explanation and record results. They will explain in the write up how the experiment is conducted to try to make it "a

fair test" for each different model. A summary statement concludes how water in sediment beneath a home affects the response of the building to an earthquake and statements will be justified using the observations made with the models in the experiment.

Students gain a greater appreciation of how a seismograph works, and a better understanding of recordings of ground motion that they see on seismograms by building their own seismograph using common materials in groups of three to four students. Students then demonstrate to each other how their seismograph records motion.

[http://www.iris.edu/hq/files/programs/education\\_and\\_outreach/aotm/8/1.SeismographModel-Lahr.pdf](http://www.iris.edu/hq/files/programs/education_and_outreach/aotm/8/1.SeismographModel-Lahr.pdf)

Students use recent three component seismic data to locate an earthquake. They identify P and S waves on seismograms, find the distance of an epicenter from a seismic station using travel time curves, locate the epicenter of an earthquake by triangulation, and calculate the time of origin of an earthquake based on seismic data. [http://www.iris.edu/hq/resource/locating\\_earthquake](http://www.iris.edu/hq/resource/locating_earthquake)

**Key Assignments:** *Detailed descriptions of all Key Assignments which should incorporate activities and projects, as well as, short answers and essay questions. How do assignments incorporate topics? Include all assignments that students will be required to complete. Assignments should be linked to components mentioned in the course outline. It is not appropriate or necessary to include instructions given to students regarding the execution of assignments (formatting, timeliness, etc.). Do not include exams or assessments in this section.*

### **Recurring Assignments**

#### Odd numbered Units:

Disasters in the News Blog – students post updates on the class wiki regarding disaster events in the news.

Mapping and data collection – students record major events on a large map in the classroom with color-coded dated stickers. (See 3.b laboratory activity described above). Students post summaries of events on class wiki including hyperlinks to the news sources referred to for reporting the event. Class members will be required to comment on event summaries at least once every two weeks.

Online portfolio – Students will develop personal and team online portfolios for research into disaster events and possible mitigation strategies. They compare proposed responses and actual responses. Students apply an Earth System Science approach to analysis of situations and events and develop Mind Maps after each analysis.

#### Even Numbered Units:

The FEMA Hazus-MH workbooks will be used during the course to guide students through software exercises and review each unit using short answer and essay questions to interpret results of hazard analyses run.

## Key Assignments

(Unit 1) Is There a Map for That? – Introduction to GIS and the Geology of Earthquakes

- Classroom Evacuation Plan Evaluation
- Geologic Hazard Map of California – Earthquake Investigation
- Natural Resources Map of California Comparison to Geologic Hazard Map
- Hazard City: Assignments in Applied Geology: Earthquake Damage Assessment
- Design an Earthquake Kit

(Unit 2) Hazus Earthquake Review

- Students download a shakemap from the United States Geologic Survey, prepare and incorporate the file into an earthquake analysis of the area chosen.
- Students use the Advanced Engineering Building Module to analyze the effect of the following variables on site specific inventory:
  - i) soil type
  - ii) liquefaction effects
  - iii) attenuation function and
  - iv) magnitude

(Unit 3) Is There a Map for That? Streams, Floods, and Mass Wasting

- Students develop a drainage Basin Map for the school area and a supporting explanatory pamphlet/information sheet.
- Hazard City Assignments in Applied Geology: Flood Insurance Rate Maps, recommendation report to homeowners concerning amounts of flood insurance to purchase.
- Hazard City Assignments in Applied Geology: Landslide Hazard Assessment
- Written scientific report on probability of a flood and/ landslide event on the school campus and surrounding neighborhood, possible consequences and recommended responses.

(Unit 4) Hazus Flood Review

- Students download a digital elevation model through Hazus-MH to analyze flood risk in a study area.
- Students use the Flood Information Tool to process and convert locally available flood information to data that can be used by the Hazus-MH Flood Module.

(Unit 5) “In Hertford, Hereford and Hampshire, Hurricanes Hardly Ever Happen.”

- Students create a “Severe Weather Poster” to educate the school population regarding forms of severe weather, and present possible safety precautions.
- A World Map will be used to identify hurricane regions and time of year for major activity with proposed explanation for a “no hurricane zone” close to equator.
- Hazard City Assignments in Applied Geology: Hurricane/Tsunami Hazard Assessment.

(Unit 6) Hazus Hurricane Winds Review

- Students list abiotic factors and analyze historical hurricane patterns to identify areas within the United States prone to hurricane hazards.
- Students run a probabilistic hurricane analysis and identify loss mitigation factors.

(Unit 7) What a Disaster!

- Research project and oral presentation to peers.
- Part 1. Assigned teams of up to four students develop a proposal for their final research project. The proposal will outline a hazard plan for a selected disaster and the assessed risk for that disaster in the study area. A work breakdown structure detailing student roles in the team and a timeline outlining the steps that will need to be taken in order to complete the project on time will be required. Students create their own checklist for making sure the steps towards completion are met for each team member and implement procedures to keep team members on task.
- Part 2. Students research a historic or recent disaster event and construct a description of that disaster for their classmates including when, where, why, what and how, the casualties and level of destruction, emergency response and long term consequences. Students assess what could have been done differently to mitigate damages or what the effect might be if a disaster of the same level were to strike today. Students use a team wiki space to record all their individual research findings including references and compile a final edited team wiki product.
- Part 3. Students prepare a ten-minute summary presentation of their findings and analysis.
- Part 4. Individual students submit:
  - A mind map for the disaster their team researched
  - A written reflection on the team activities, their personal learning during the final project, and the possible adjustments to the group presentation that could make it suitable for school wide or community “Disaster Education” events.

(Unit 8) Risk Assessment Review — Students will work in teams to develop a comprehensive risk assessment for a study area as a capstone project for the class. The risk assessment will be presented both in a multimedia format and as a technical written document.

**Instructional Methods and/or Strategies:** *Indicate how the Instructional Methods and/or Strategies support the delivery of the curriculum. What portions of the Course Outline are supported by the methods and strategies?*

- Direct instruction through lecture in both academic and software class sections (Units 1-8)
- Guided practice using FEMA Hazus workbook exercises (Even numbered units)
- Collaborative group work to develop capstone project (Units 7- 8)



- Laboratory exercises correlated with science standards (Odd numbered units)
- Collaborative team teaching – the academic (geology) teacher and the CTE (Hazus) instructor alternate instructional time to connect academic concepts with practical applications (Units 1-8)
- Research – library and internet (Units 1,3,5,7,8)
- Self and peer critiques to improve writing literacy (Units 1,3,5,7,8)
- Interactive instruction (involves changing parameters in the Hazus-MH program to evaluate mitigation strategies for different natural disasters) (Even numbered units)
- Daily assignments for both class sections (Units 1-8)
- Cornell note taking strategies for lecture portion (Units 1-8)
- Field experience using handheld GPS (Units 1,3)
- Online assignments correlated to science standards (Odd numbered units)

**Assessments Including Methods and/or Tools:** *Indicate the intent of each assessment and a brief description of how each relates to the Course Purpose and goals related to the development of critical thinking and other habits of mind skills.*

- Formative assessments — checks for understanding, acquisition of information
- Assigned unit exercises using Hazus-MH — allows students practice and familiarity with Hazus-MH software
- Section quizzes — confirms assimilation of subject material
- Written composition and reports — demonstrates application of subject material and literacy in the content area
- Laboratory exercises — practical application of subject area
- Unit tests — assesses comprehension of material
- Interim assessments — assesses mastery of subject
- Presentations — learning is further developed by teaching others
- Midterm — assesses comprehension and retention of material
- Comprehensive final — assesses comprehension and retention of material
- Capstone project – documents students’ ability to adapt course material to real-world predictable and unpredictable situations