IN NEED OF REPAIR:
THE STATE OF K-12
COMPUTER SCIENCE EDUCATION
IN CALIFORNIA

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A Report for ACCESS, the
Alliance for California Computing Education
for Students and Schools,
with support from the
Computer Science Teachers Association

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ABSTRACT

This report has been drafted for the Alliance for California Computing Education (ACCESS) with support from the Computer Science Teachers Association. ACCESS consists of computer science education leaders from the K-12, community college and university level—including teachers, administrators, professors and researchers—along with California educational policy staff—including the California Department of Education. ACCESS is working to address the need for educational policy changes and educational reform regarding computer science education in California. This report is intended to inform the efforts on which ACCESS embarks in this respect.

This report describes the general K-12 education landscape in California as a foundation and provides details related to the current computer science education landscape, including but not limited to: computer science courses available to students, credentialing of computer science teachers, professional development opportunities for educators, and funding opportunities related to the support of computer science education.

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David Bernier of UCLA conducted the research and authored the first version of this report. The report was edited by Chris Stephenson, Executive Director of the Computer Science Teachers Association, Debra Richardson, Chair of the Alliance for California Computing Education for Students and Schools (ACCESS), and Gail Chapman, Director of National Outreach, Exploring Computer Science at UCLA.

Numerous individuals were contacted as part of the research for this report, particularly at the California Department of Education and California Commission on Teacher Credentialing, as well as individuals involved with the University of California Office of the President, Computer Science Teachers Association, and other organizations that had information pertinent to this report. Special thanks go to Gary Page, Roxann Purdue, Rebecca Parker, Lloyd McCabe, Marjorie Suckow, Tom Adams, Nina Costales, Gail Chapman, Dan Lewis, and particularly Jane Margolis for their invaluable contributions.

TABLE OF CONTENTS

INDEX OF TABLES

EXECUTIVE SUMMARY

Introduction

According to World Bank figures for the year 2009, California would have the world's 8th largest economy if it were its own country, with a gross domestic product of $1.9 trillion. [i] The state's leading export category in 2009 was computers and electronic products, which alone accounted for $35.2 billion, or 29 percent of California's total merchandise exports. In 2009, over 23,000 patents originated in California, far more than any other state. [ii] Contributing greatly to this innovation and wealth are major Fortune 500 companies focused on technology such as Apple, Cisco, Google, Hewlett Packard, Intel, and Oracle.

According to data gathered from the National Center for Women in Information Technology, California will have an average of more than 20,000 computing job openings each year for the next five years. Filling these openings requires an educated and qualified workforce. Such a workforce will not exist unless California's K-12 students are given engaging, meaningful, and adequate exposure to computer science at their schools and beyond as these are the critical years for shaping inclinations and decisions for career paths. [iii]

Yet the current state of K-12 computer science education in California and the structures that impact its future viability are a troubling, confusing, and patchwork arrangement requiring serious reform. The major segments that impact the development and quality of the infrastructure of computer science education include:

- The courses students have the opportunity to take with their varying levels of usefulness, engagement, and credit;
- The positioning of computer science within the academic and career programs of study;
- The teachers who have the credentials and the needed computing skills and knowledge;
- The professional development and material resources needed to teach effectively;
- The funding structures which impact the courses that will be taught and by whom.

Combined with these larger issues are the particular policies of various state agencies and their quality control efforts that are often applied in overly complex and conflicting ways.

Due to the sad state of K-12 computer science education, California is at risk of losing its competitive advantage to other states, like Texas and Georgia, or to other countries such as Israel, Ireland, India, China and eastern European countries, where investment and development of K-12 computer science education have taken priority. Take Texas, for instance: although computer science is not a required course for graduation, there are 11 "standardized" courses that qualify for computer science; there is a single subject teacher certification in computer science; computer science is taught in roughly half of the 1500 high schools in the state; there is also a strong state-wide extracurricular program delivering computer science education; see Appendix D for a more thorough description of computer science education in Texas. In Israel: computer science has been taught as an independent subject since the mid-70s with a new curriculum in place since the early-90s

that emphasizes principles and foundations of algorithmic thinking; all teachers must be certified by the Ministry of Education; computer science teachers must have an undergraduate degree in computer science and graduate from a teacher preparation program. If California is to remain competitive in the global economy, it must place more priority on computer science education in its schools.

Background

A Lack of Access to Computer Science Opportunities

In 2010, 2,793 California students took the Advanced Placement (AP) Computer Science exam. By comparison 22,163 took Advanced Placement European History, 16,302 students took Advanced Placement Environmental Science, and 2,138 students took Advanced Placement Chinese Language and Culture. Of further concern, only 33 of the students who took AP Computer Science were self-identified as black and 230 as Latino/a. These numbers have been flat or gradually trending downward in recent years. See Appendix A for more details on AP CS test takers.

Furthermore, when one looks beyond (before) the advanced levels of computer science to simply taking a computer science course, the numbers are no more promising. The statewide enrollment data show declining enrollments and participation in computing courses – for the 2008-2009 school year, California Department of Education (CDE) data shows that fewer than 10% of students in grades 7 through12 had taken a computing course. In addition, the overall course enrollment figures for computing courses are significantly lower than those of other courses such as Biology and United States History, which had twice as many students enrolled in them.[iv] See Appendix A for more details on computing course enrollments statewide. These numbers might be related to fiscal pressures, dictates of NCLB, a lack of qualified teachers, the impression that computer science does not need to be taught due to the ubiquity of computers, or the lack of student interest. Regardless of the reason, the situation needs to change.

Moreover, there is a dearth of underrepresented minority students majoring in computer or information sciences in California colleges and universities. In 2002, only ten African American and 39 Latino students enrolled at all of the UC schools had declared a computer or information sciences major. Six years later, only eight African American and 25 Latino students graduated with computer or information sciences degrees.[v] Without significant reforms and opportunities at the K-12 level, these numbers will not improve.

In the Los Angeles Unified School District (LAUSD), a different computer science narrative began in 2008 with the introduction of a new course called *Exploring Computer Science* (ECS). ECS is designed to acquaint students with many of the fundamental concepts and fields of computer science. The vast majority of the students enrolled in ECS in LAUSD are from underrepresented populations. Enrollment has grown significantly in the years since, and also expanded into several school districts in northern California. See Appendix A for more details on demographics in ECS in LAUSD and also on ECS enrollments statewide.

Another effort to address the inaccessibility of computer science courses was initiated in 2009 by the larger computer science community to develop a new advanced placement course that would be more welcoming than the AP Computer Science A course (Java programming). *Computer Science: Principles* is designed to introduce students to the central ideas of computing and computer science, to instill ideas and practices of computational thinking, and to have students engage in activities that show how computing and computer science change the world. The proposed curriculum framework for a new *AP Computer Science: Principles* course is designed to complement the existing course in computer science modeled by the AP CS A course. Through both its content and pedagogy, *CS: Principles* aims to appeal to and be accessible by a broad audience. CS: Principles is being piloted in three regions in California.

Positioning of Computer Science Education

The positioning of Computer Science courses within the California course frameworks impacts both student enrollment and teacher qualifications.

The majority of California's college-bound students are preparing themselves to attend either the University of California (UC) or the California State University (CSU); both UC and CSU require entering freshman to have completed a set of college preparatory courses, known as the "a-g" requirements. Thus, to attract college-bound students to computer science, it is necessary that it be qualified as a college preparatory course. If college bound students do not get college preparatory credit for computer science, it may be difficult to fit it into their schedule and thus, even if interested, they are less likely to take it.

Career and Technical Education (CTE) courses connect academic content standards with industry-specific knowledge and skills to prepare students for direct entry into the workplace and also for postsecondary education. The current California CTE is intended to emphasize 21st century labor market realities, flexibility, and adaptability to local CTE conditions and also to integrate California's academic content standards with industry-specific knowledge and skills to prepare students for direct entry into the workplace as well as for postsecondary education.

Courses can be simultaneously approved as satisfying an "a-g" requirement and as a CTE course when they support students in preparing for a career or college or both, and the California Department of Education is encouraging this practice (sometimes called linked learning).

Other considerations as to where to position computer science education include:

- Positioning computer science within the realm of CTE could have significant financial benefits, because CTE is a good source of potential funding.
- There remains widespread perception that CTE course codes on student transcripts equate to vocational courses, so potential academic ramifications must be considered alongside financial considerations.
- The teaching credential or preparation required for someone to teach the course sometimes differs depending on whether the course is college preparatory or career technical education and also may differ by school districts.

Credentials and the Computer Science Teaching Force

Strong computer science programs in K-12 require well-prepared teachers. Although computer science is a field that is driving innovation and job growth in California, the current credentialing structures are sadly outmoded and largely ineffective. California offers credentials in Agriculture and Industrial and Technology Education but does not have a credential in Computer Science. Furthermore, the fragmenting of computer science into the credentials of Mathematics, Business, and Industrial Technology Education as well as the supplementary authorization in Computer Concepts and Applications is confusing for potential teachers and administrators alike.

Section 1: COURSE FRAMEWORKS

This section focuses on the California K-12 education landscape – in particular the course structures that exist, including the higher education framework (a–g requirements) that guides much of the course development at the high school level and Career and Technical Education (CTE) standards and framework. Current political efforts that may impact computing education in California are also discussed.

1.1 College Preparatory Courses

The University of California (UC) and California State University (CSU) require entering freshmen to have completed a set of 15 college preparatory courses in high school, known as the "a-g" requirements. The intent of the "a-g" subject requirements is to ensure that the student has attained essential critical thinking and study skills and a body of general knowledge that will provide breadth and perspective to new, more advanced study, and therefore can participate fully in the first-year program at the University in a wide variety of fields of study.

The "a-g" requirements are more rigorous than the state high school graduation requirements; many students who graduate from high school do not meet "a-g" requirements. For the class of 2008, only 35% of students statewide completed "a-g" requirements upon graduation. According to the California Department of Education (CDE), data for the same year (2007-08), 68.3% of public school students in California graduated, up from 67.7% the previous year, while 70.1% of graduated the following year (2008-09). Increasingly, however, districts in the state are aligning their high school graduation requirements to the "a-g" requirements for UC/CSU admission, including Los Angeles, Oakland, and San Jose.

1.1.1 "A-G" Requirements Framework

In the "a-g" requirements, each subject area has been assigned a letter, as follows:

(a) History / Social Science – Two years, including one year of world history, cultures, and historical geography and one year of U.S. history or one-half year of U.S. history and one-half year of civics or American government.
(b) English – Four years of college preparatory English that include frequent and regular writing, and reading of classic and modern literature.
(c) Mathematics – Three years of college preparatory mathematics that include the topics covered in elementary and advanced algebra and two- and three-dimensional geometry.
(d) Laboratory Science – Two years of laboratory science providing fundamental knowledge in at least two of these three disciplines: biology, chemistry, and physics.
(e) Language Other Than English – Two years of the same language other than English.
(f) Visual & Performing Arts – One year, including dance, drama/theater, music, or visual art.
(g) College Preparatory Elective – One year (two semesters), chosen from additional "a-f" courses beyond those used to satisfy the requirements above, or courses that have been approved solely for use as "g" electives.[vi]

For a course to be certified as meeting an "a-g" requirement, a detailed syllabus (as well as other pertinent information) must be submitted to the University of California Office of the President (UCOP) for approval. The UC faculty has ultimate authority for determining whether courses meet the rigor and content guidelines to be certified as a college preparatory ("a-g") course for UC and CSU. That work takes place at the UC Office of the President under faculty supervision. When a course is submitted to UCOP, the UC Office of Undergraduate Admissions and the subject matter expert review it through a blind review process. The reviewers examine the entire course description/outline, particularly analyzing the academic rigor of the course including the number and level of prerequisites, level of student work required, how the subject specific questions were addressed, and depth of the key assignments. Based on these criteria and others outlined in a checklist, each reviewer independently determines if a course can be approved based on faculty guidelines. [vii]

Section 2.3 discusses current positioning of computer science courses as college preparation in the "a-g" requirements.

1.2 Career and Technical Education Courses

Career Technical Education (CTE) courses connect academic content knowledge with practical or work-related applications. The current California CTE is intended to emphasize 21st century labor market realities, flexibility, and adaptability to local CTE conditions and also to integrate California's academic content standards with industry-specific knowledge and skills to prepare students for direct entry into the workplace as well as for postsecondary education.

1.2.1 CTE Standards and Framework

Educational standards and frameworks can only be developed and enacted in California through legislation. The California Career Technical Education (CTE) Model Curriculum Standards were adopted by the State Board of Education in May 2005. These standards resulted from Assembly Bill 1412 and Senate Bill 1934, which mandated that an advisory group oversee development of CTE curriculum standards and frameworks to structure the teaching and learning of CTE in California.

The CTE standards differ from those for academic core subjects. The heterogeneous nature of the subject matter and course delivery patterns make it impossible to develop course- or grade-specific standards for CTE subjects. As a result, the content, sequencing, availability, structure, and nomenclature of CTE courses vary significantly among school districts and sometimes even among schools within a district. Although CTE courses are developed according to industry sector standards, each school offers courses that reflect the local district's employment preparation needs.

The California Department of Education is currently reviewing and updating the state's CTE Model Curriculum Standards and Framework. The standards writing teams will be completing the design and development of the recommendations in early November.

There will be an electronic public review of the standards to be completed in late January. The goal is to have the final draft document ready for review by June 2012.

1.2.2 CTE Industry Sectors

The CTE standards are currently organized into 15 industry sectors of interrelated occupations and broad industries:

1. Agriculture and Natural Resources
2. Arts, Media, and Entertainment
3. Building Trades and Construction
4. Education, Child Development, and Family Services
5. Energy and Utilities
6. Engineering and Design
7. Fashion and Interior Design
8. Finance and Business
9. Health Science and Medical Technology
10. Hospitality, Tourism, and Recreation
11. Information Technology
12. Manufacturing and Product Development
13. Marketing, Sales, and Service
14. Public Services
15. Transportation

Each sector has two or more "career pathways", which are a coherent sequence of academic and technical courses that allow students to apply academics and develop technical skills in a curricular/industrial area. Each pathway includes an introductory course (which may be offered at the middle school level) followed by two or more concentration and/or capstone courses. Career pathways are intended to prepare students for successful completion of state academic and technical standards and postsecondary course-work related to the career in which they are interested.

The Information Technology sector is most related to computer science. Section 2.4 discusses courses and pathways in this sector and the positioning of computer science in CTE.

1.2.3 CTE Programs of Study

A "program of study", or course sequence, is an explicit series of related CTE courses that fit together in grades 9-12. A program of study aligns the content and technical knowledge and skills needed to prepare students for further education and careers. In general, a program of study is a selection of three courses at appropriate levels from a career pathway.

1.2.4 CTE Tech Prep Programs

Tech Prep programs are designed to link high school and two-year college programs in specific technical fields and occupational areas. They are defined as planned sequences of study in technical fields beginning as early as grade nine and linked to two years of postsecondary occupational education or apprenticeship programs of at least two years

following secondary instruction. The sequence culminates in an associate degree or a certificate.

1.2.5 Various Approaches to Support Career Technical Education

Regional Occupation Center Programs

Initiated in 1967 to serve high school students and adults, Regional Occupation Center Programs (ROCP), constitute the largest delivery system for CTE in California. Programs are operated by county offices or by districts working on their own or under joint-powers agreements. Their roles are to address equipment cost and ensure that a full range of options is offered across a particular geographic area. Statewide, ROCPs offer more than 100 career pathways and programs as well as career exploration, career counseling and guidance, and job placement assistance. ROCPs work with industry or pathway-specific advisory groups to update curricula annually to address labor market needs. ROCPs received $421 million in 2005 and served about 1.5 million students, the highest enrollment occurring in Business and Information Technology and Industrial Technology.[viii]

California Partnership Academies (CPA)

California Partnership Academies provide technology skills and certification, business ethics, and scholarships to students to prepare them for jobs in highly competitive fields and opportunities for higher learning. CDE provides annual grants to ~500 CPAs. These range from $42,000 to $81,000, depending on the stage of academy development (first through third year). It takes 3 years for all three classes to become enrolled. The grants are allocated by periodic competitive grant applications from interested high schools/ districts.

The National Academy Foundation

The National Academy Foundation (NAF) is a national group dedicated to preparing young people for college and career success. The NAF model includes industry-focused curricula, work-based learning experiences, and business partner expertise from our four areas: Finance, Hospitality & Tourism, Information Technology, and Engineering. Schools wishing to participate in the program must join the network and pay an entry fee ($6-12K).

Linked Learning Alliance

The Linked Learning Alliance is a statewide coalition of education, industry, and community organizations dedicated to improving California's high schools and preparing students for postsecondary education and career. The Linked Learning Alliance was founded by a grant from the Irvine Foundation in May 2008, and has many notable supporters including Tom Torlakson, the California State Superintendent of Public Instruction. The alliance has the expressed aim of expanding student access to high-quality linked learning pathways.

A linked learning pathway is a program of study that connects learning in the classroom with real-world applications outside of school. The linked learning approach seeks to integrate rigorous academic instruction ("a-g") with demanding technical curriculum (CTE) and work-based learning, with the intention of making learning more relevant and

engaging. It organizes learning around a pathway in the context of one of California's 15 industry sectors (the sectors around which CTE is focused – see section 1.2.2).
Each linked learning pathway contains four essential ingredients. [ix]

1. A challenging **academic component**
2. A demanding **technical component** that delivers concrete knowledge and skills through a cluster of three or more technical courses. The focus is on preparing youth for high–skill, high–wage employment through an emphasis on real–world applications that bring academic and technical learning to life.
3. A **work–based learning component** that offers opportunities to learn through real–world experiences.
4. **Support services** including counseling as well as additional instruction in reading, writing, and mathematics.

1.2.6 Potential Legislation Impacting Career Technical Education

There are a number of active bills in Sacramento that have implications for computing education in California. All of these bills involve CTE. Although they are not ensured of passage, these bills reveal some of the key players politically supporting CTE and current political thinking underlying the legislation.

AB 1330, authored by Assemblyman Warren Furutani of Los Angeles/Long Beach, was signed by Governor Brown in October 2011. AB 1330 provides students with the option of substituting one course in career technical education (CTE) to fulfill the high school graduation requirements for visual and performing arts or foreign language. By including CTE as an area to meet graduation requirements, the hope is that more students will take CTE courses as well as complete graduation requirements. Governor Schwarzenegger vetoed an earlier version of this bill in 2010 because of potential costs. Understandably there has also been much opposition from supporters of foreign language and the arts. There are also concerns that the numbers of students who fulfill "a-g" requirements (which include arts and languages) would decline as students if students chose to take CTE courses instead.

Warren Furutani was a former member of the LAUSD school board and has demonstrated a history of support for civil rights, helping campuses establish ethnic studies programs and working to get Manzanar designated as a historical site. He was also a graduate of Gardena HS, a school that currently offers Exploring Computer Science.

SB 275, authored by Senator Loni Hancock (Berkeley/Oakland), seeks to maintain state CTE funding. Existing law provides funding for various career technical education programs, including regional occupational centers and programs, specialized secondary programs, partnership academies, and agricultural CTE programs. Commencing with the 2015–16 fiscal year and for each fiscal year thereafter, this bill would require, for each of these programs, that the Superintendent of Public Instruction apportion to each county office of education an amount based on the same relative proportion that local educational agencies within that county received in the 2007–08 fiscal year.

Senator Hancock has stated that she strongly believes in career academies because they

keep young people in school, and better prepare them for college and for jobs in the new economy. Senator Hancock currently chairs the Select Committee on Workforce Development, School Environment, and Student Wellness.

SB 611, authored by Senator Darrell Steinberg, was signed by Governor Brown in October 2011. SB 611 funds additional UC Curriculum Integration Institutes (UCCII) with the expressed goal of creating innovative CTE courses that can be UC approved. UCCII are professional development institutes that bring together academic and career technical high school teachers, administrators, and experts from across California for a four-day training dedicated to "a-g" course development. Teams are formed to design innovative model courses that integrate CTE and "a-g" curriculum capable of statewide implementation.[x]

SB 612, also authored by Senator Steinberg, was signed by Governor Brown in October 2011. SB 612 mandates that CTE become part of the California Subject Matter Project (CSMP). Although the focus of the bill is on existing CSMPs, this bill also adds two new areas of emphasis for CSMP. According to senate analysis of the bill, it seeks to provide teachers with:

1. Instructional strategies for delivering career-oriented, integrated academic and technical content in a manner that is linked to high priority industry sectors identified in the California Career Technical Education Model Curriculum Standards as adopted by the State Board of Education.
2. Instructional strategies for ongoing collaboration on the delivery of career-oriented, integrated academic and technical education content.

Darrell Steinberg is the Senate President pro tem and an influential member at the state level. Steinberg could be a strong supporter for future efforts to shape computer science education. According to his website, as a member of the State Assembly, he "authored legislation to focus additional education resources on high-poverty schools and make them accountable for improvement". Senator Steinberg has also authored ***SB 547***, which seeks to change the accountability structures for schools by putting more value on "college and career" preparedness in determining a school's academic performance. According to a source at CDE, Steinberg is also a big supporter of the blended approach of combining college preparation with career preparation.

1.3 Career Technical co-listed as College Preparatory Education

CTE courses can also be approved as satisfying an "a-g" requirement by UCOP. In fact, courses such as AP Computer Science and Exploring Computer Science are often simultaneously CTE and college prep courses. Furthermore, the California Department of Education is very interested in supporting courses that are simultaneously "a-g" and CTE as they support both career and college preparation. There are currently 9,979 CTE courses meeting UC "a-g" admission requirements for 2010-11 (covering all areas of "a-g"). CTE/"a-g" courses must satisfy the following conditions:

- Provide high-quality, challenging curricula that use and advance concepts and skills in the "a-f" subject areas; and,
- Integrate academic knowledge with technical and occupational knowledge; and,

- Include tasks that are rich in opportunities to develop knowledge of tools, processes and materials; to engage in problem-solving and decision-making; and to explain what one is doing and why.

According to the UCOP website, CTE courses should demonstrate a close connection with the academic curriculum requiring at least one prerequisite or co-requisite, or must be an advanced course designed for the 11th or 12th grades. Approved courses may be designed to emphasize academic concepts using career-related applications to make ideas accessible to students. Conversely, these courses may be designed using career and technical applications to provide an entry point for understanding theoretical or technical aspects of an academic discipline. [xi]

According to contacts at UCOP, the CTE designation for some approved courses is manually added on after the course is approved if the school did not designate the course as a CTE course in their submission. The California Department of Education annual report on "a-g" CTE courses designates those approved "a-g" courses as CTE courses; and thus the CTE designation may not be added to some courses until the a number of months after the course is approved. Due to some technical issues, some of the courses that should be designated as CTE are not showing up as such on the Course List website. UCOP is working with its technical staff to fix this issue.

1.4 Common Core Standards

In 2010, California adopted the Common Core Standards (CCS) in English, Language Arts and Mathematics, thus committing to realign standards and curriculum across pre-kindergarten through grade 12. The Mathematics standards are written to include the use of mathematical skills and concepts in fields such as science, technology, and engineering. These standards emphasize the ways in which students should use literacy and numeracy skills across the curriculum and in life, engaging in real life applications, analyzing issues, and using knowledge to solve complex problems. [xii]

The team that is currently reviewing the CTE Model Curriculum Standards will also align the CTE Standards to the Common Core Standards where applicable.

Section 2: POSITIONING OF COMPUTER SCIENCE

This section focuses on the current positioning of computing courses, both as college preparation and career technical education. The computing courses taught in the ten largest California school districts are summarized along with their positioning in California education frameworks. Because the vast majority of courses are at the high school level with just a sprinkling of opportunities at the elementary and middle school level, this report focuses on computer science at the high school level but provides a short summary of middle school opportunities.

2.1 Middle School Computer Science

At the middle school level (grades 6–8), some districts offer an introduction to computers course with elements of keyboarding, basic applications, and a sprinkling of web design. The Long Beach Unified School District, for example, offers three semester-long courses to middle school students with the aforementioned topics as well as development of spreadsheets and databases and desktop publishing. Other districts, particularly in northern California, offer computing-related electives such as Piedmont Middle School's Computer Graphics course with Flash, Dreamweaver and CAD, and Redwood Middle School's computing class focusing on programming and web tools. These schools, however, appear to be the exception rather than the rule as many middle schools have one introductory course at most (typically keyboarding or computer literacy) and others do not have any courses at all. A number of schools have computing-related clubs such as robotics but these are extra-curricular in nature and typically found at higher socioeconomic status schools. One of the highest achieving middle schools in the state—American Indian Public Charter School—does not have computers for kids and does not offer computer science courses because they believe a "vast majority know their way around a computer" and "because there isn't a computer science section on the SAT, and we want to get our kids into college, so we worry first about this."[xiii] On the whole, computer science courses are available to a very limited number of students and at very basic levels at the middle school level.

2.2 High School Computer Science

At the high school level, the computer science course offerings are much more extensive and often linked to the "a–g" requirements for college admission to the UC and CSU systems. Still, computer science is not a required course in state-level high school graduation requirements. Under "local control", however, districts may and often do add to the state's minimum course requirements for high school graduation.

In addition to Advanced Placement Computer Science, there are two growing offerings of computer science courses in the state. These are Exploring Computer Science and varying instantiations of Computer Science: Principles.

2.2.1 Exploring Computer Science

A new course entitled *Exploring Computer Science* (ECS) was developed through collaboration between the University of Oregon and the Computer Science Equity Alliance

for schools in Los Angeles Unified School District (LAUSD). ECS is an entry-level (grades 9 or 10) high school computer science course designed to introduce students to many of the fundamental concepts and fields of computer science. ECS was first piloted in LAUSD during the 2008-09 academic year, and is being introduced to a growing numbers of schools in LAUSD, including ten additional schools during this school year (2011-12). The vast majority of the students enrolled in ECS are from underrepresented populations. Furthermore, most of these students had not had any prior exposure to computer science courses before ECS, and many of these students are reporting an increased interest in computing courses and careers.

The ECS course has expanded in California to several school districts in Northern California. See Appendix A for more details on demographics in ECS in LAUSD and also on ECS enrollments in various school districts statewide.

2.2.2 Computer Science: Principles

Members of the computer science community are currently developing a curriculum framework for a new *AP Computer Science: Principles* course, designed to complement the existing AP Computer Science A course. *AP Computer Science: Principles* is a second level course designed to introduce students to the central ideas of computing and computer science, to instill ideas and practices of computational thinking, and to have students engage in activities that show how computing and computer science change the world. The proposed course is rigorous and rich in computational content, includes computational and critical thinking and skills, and engages students in the creative aspects of the field. CS: Principles seeks to broaden participation in computing and computer science.

CS: Principles is a pilot course whose development is being led by a team of computer science educators organized by the College Board and the National Science Foundation. CS: Principles is not yet an official Advanced Placement course being offered by the College Board, but is being piloted in approximately 15 regions across the country, including three pilots in California partnered with universities – UC Berkeley and UC San Diego were phase I pilots in 2010-11, while Stanford University is a phase II pilot in 2011-12.

2.3 Computer Science as College Preparatory Education

The 2010–2011 a–g approved course list shows 86 courses with the words "Computer Science" in the title. Of those 86 courses, 22 have titles with advanced placement or "AP" in them. When the number of schools (459) offering approved courses and the courses they are offering for UC approved credit are combined, the results indicate that Advanced Placement (AP) Computer Science is the most commonly taught course approved for college preparatory credit and that it is offered through 325 schools. Exploring Computer Science is the second most commonly offered course with 33 schools. The generic "Computer Science" titled course and "Computer Science I" are offered in 23 and 21 schools, respectively. [xiv]

There are 326 courses with "computer" in the title. These include all of the previously mentioned computer science courses such as AP Computer Science as well as courses like

"computer art," "computer graphics," and "computer programming." Again, AP Computer Science is offered by the most institutions. The second most commonly offered courses, with 77 schools, are courses with "computer programming" in their titles. [xv]

The UC "a-g" computer science course data also shows the subject area and category of approval and its links to Career and Technical Education (CTE). According to contacts at the University of California Office of the President (UCOP), the correct category for AP Computer Science A is Elective (Mathematics). In the older course list update system, when schools added an elective course, however, the category selection automatically defaulted to "History/Social Science". If a school neglected to change this default, the AP Computer Science course was mistakenly identified as a History/Social Science course. This explains why so many of the schools offering AP Computer Science have had the course listed as an elective under the History/Social Science category.

Nearly all of the UC "a-g" approved computer science courses are designated as "g" college preparatory electives with AP Computer Science, Exploring Computer Science, and other programming classes falling within this designation. Furthermore, the UC faculty who make the ultimate determinations of placement have indicated that computer science courses should be listed in the math elective or in some cases math subject area categories going forward. The UC office is currently going through the process of cleaning up these designations as well as trying to improve uniformity for AP CS course listing so that the designation is consistent with the College Board course trademark.

In order to be approved as a "g" credit, a computer science course must fulfill the following objectives:

- Teaches students to express algorithms in a standard language;
- Requires students to complete substantial programming projects; and
- Involves the study and mastery of various aspects of computer architecture (e.g., how computers deal with data and instructions, the internal components of a computer and the underlying computer logic).[xvi]

UC has only given a few computer science courses the "c" math designation. According to a UCOP source, the language around math changed somewhat in 2010 and schools seeking a "c "math designation must resubmit their courses for approval.

Under the math requirements description, UC indicates that "other rigorous courses that use mathematical concepts, include a mathematics prerequisite, and that are intended for 11th and 12th grade students, such as discrete mathematics or computer science may also satisfy the requirement. Such courses must deepen students' understanding of mathematics.[xvii]

Presently there are no "d" computer science courses. "D" courses correspond to Lab Sciences and some contend that this category could work for computer science. According to contacts at UCOP, "the intent of the laboratory science ("d") subject requirement is to ensure that students have exposure to at least two of three foundational sciences of biology, chemistry, and physics. UC faculty believe that these three science subjects are

preparatory to university-level study in all scientific and science-related disciplines. In addition, one of the UC's requirements for all laboratory science courses, including those science courses approved in the elective ("g") subject area, is that they must dedicate at least 20% of class time to hands-on scientific labs." [xviii]

In addition to these parameters, the subject requirement criteria for the "d" subject area was re-evaluated and re-written in 2009 by the Board of Admissions and Relations with Schools (BOARS). BOARS establishes the subject areas and pattern of courses required for freshman admission to the University of California. BOARS is a committee of the University's Academic Senate and includes faculty representatives from each campus of the University. When asked about the possibility of computer science receiving "d" credit, a member of BOARS responded, "As far a lab science goes I think it very unlikely that BOARS would consider computer science in that realm. The area "d" requirements are specifically based upon biology/life sciences, chemistry, and physics, because these subjects are preparatory to university-level study in all scientific and science-related disciplines. Computer science fits more naturally into the mathematical sciences (it doesn't have an experimental basis as do the others.)"

Recently, Robert Schwartz, Executive Director of the Level Playing Field Institute proposed the idea that "the UC system should be innovative and grant high school students credit for learning a computer language as their "e" requirement of two years of a "Language Other Than English." While this idea is innovative, it is unclear how much support there would be for this proposal in the computer science community, in UCOP, and in CDE.[xix]

See Appendix B for an overview of some of the various strengths and weaknesses related to the positioning of computer science courses in the "a-g" requirement structure.

2.4 Computer Science as Career Technical Education

As mentioned previously, the California CTE sector most related to computer science is the Information Technology Industry sector. CTE courses in the IT sector are listed under the broad area of Business and Marketing Education.

2.4.1 CTE Information Technology Pathways

The Information Technology sector is divided into four pathways: Information Support and Services, Media Support and Services, Network Communications, and Programming and Systems Development. (Note: These were the pathways as of the writing of this report. Pathways will change as a result of the CTE standards review process.) The Programming and Systems Development pathway most clearly aligns with the most prevalent computer science courses.

Recall that CTE programs are designed in a pathway format that supports a sequence of courses. A sequence of courses in CTE includes an introductory course (which may be offered at the middle school level) followed by two or more concentration and/or capstone courses. Shown below are the IT pathways:

Programming and Systems Development:

Introductory
- Computer Applications
- Exploratory Business
- Introduction to Programming

Concentration
- Programming and Software Development
- Java Programming
- Visual Basic Programming
- Computer Programming

Capstone
- Game Programming
- Advanced Programming
- AP Computer Science
- HTML Programming
- Web Programming
- Probability and Statistics

Information Support and Services

Introductory
- Keyboarding
- Computer Applications
- Business Communications

Concentration
- Office Technology

Capstone
- Microsoft Office Specialist Certification

Media Support and Services

Introductory
- Computer Applications
- Introduction to Business
- Introduction to Desktop Publishing

Concentration
- Desktop Publishing
- Web Design

Capstone
- Multimedia and Image Management
- Advanced Web Design

Network Communications

Introductory
- Keyboarding
- Computer Applications

Concentration
- Advanced Computer Operations
- Network Systems I

Capstone
- Network Systems II

2.4.2 Computer Science CTE Program of Study

There are several options from the Programming and Systems Development pathway that align with the most prevalent computer science courses. See Appendix C for a more detailed layout of the Programming and Systems Development pathway.

Here are a few computer science programs of study from the Program and Systems Development pathway:

Career Technical Education focus:

Introductory (grade 10)
Computer Applications

Concentration (grade 11)
Computer Programming

Capstone (grade 12)
Game Programming

College Preparatory Education focus:

Introductory (grade 10)
Introduction to Programming
Concentration (grade 11)
Programming and Software Development
Capstone (grade 12)
AP Computer Science - Java

College Preparatory – potential future program of study:

Introductory (grade 10)
Exploring Computer Science
Concentration (grade 11)
AP CS: Principles
Capstone (grade 12)
AP CS A – Java

2.4.3 Computer Science CTE Tech Prep Programs

Several CTE Tech Prep programs focused around computer science exist, linking an individual high school with a community college. A few examples that relate to computer science include:

- A Java Programming course offered at Arcadia High School that articulates with Pasadena City College for a CIS/Computer Programming track;
- A Survey of Computer Technology course offered at Alhambra High School that articulates with Pasadena City College for Introduction to Computer Information Systems/Applications as part of an IT Applications track.

2.4.4 CTE Support Programs for Computer Science

Regional Occupation Center Programs

ROCPs usually offer a range of computing courses but typically focus on lower level courses such as Microsoft Office, Web Design, Network Management, and Computer Repair. Some districts offer more advanced classes such as the Java Programming and Video Game Programming courses offered at the Fremont HS ROP. Students from surrounding districts may participate in these courses, giving them access to courses that may not exist at their local schools. Even courses such as AP CS have been offered as ROP courses as districts seek to utilize these funding sources or find instructors who may not be fully credentialed to teach these kinds of courses alternative settings. ROCP courses however typically do not have college credit associated with them because they focus largely on entry-level job preparation.

California Partnership Academies (CPA)

The Business, Engineering and Technology Academy at Herbert Hoover High School in San Diego is a CPA that has links to computer science. Classes are offered in Business Technology, Introduction to Programming, AP Computer Science, Desktop Publishing, Graphic Arts, Computer Applications, and Introduction to Business and the Internet.

The National Academy Foundation and Academies of IT

The National Academy Foundation lists the following courses under the IT category: Computer Networking, Computer Systems, Database Design, Digital Video Production, Introduction to Programming (Python), Web Design, and Principles of Information Technology. There are currently 12 Academies of IT (AOIT) in California with the majority of those in San Francisco and Los Angeles. At the end of the 2010-11 school year there were 1769 students in CA AOITs. These academies exist as schools within larger high schools. The majority of NAF academies in California also have CPA grants and are therefore part of both networks. None of the NAF courses are "a-g", but they have applied for Program Status and should be receiving that designation by the middle of August. Following that, they will be submitting all NAF courses for "a-g" approval.

Linked Learning

To date, computer science is not significantly included in linked learning models, but linked learning is a program to explore.

2.5 Computer Science Offerings Across California

Table 1 provides a glance at computer science education in California through the lens of the ten largest public school districts and their "a–g" and non "a–g" offerings in computer science as well as whether the district has a computing graduation requirement. Note that in a given district, not all of the high schools offer each of the listed courses; typically, only one or two schools offer most of the courses.

Although Mountain View-Los Altos Union High School District is not one of the ten largest school districts in California, the region is home to many high-tech companies including Google, Intuit, AOL, Adobe, Microsoft, NASA Ames, Silicon Graphics, and Oracle/Sun Microsystems. Despite this, there is no college preparatory computer science course offered at the district's two comprehensive public high schools. When contacted, educators in the district indicated that student interest is insufficient to justify the hiring of a teacher who would not have a full complement of classes to teach. With no college preparatory classes available, the perceived lack of student "interest" is actually a profound lack of access. It is interesting to note that Mountain View High School has one of the top robotics teams in the country and also placed fourth in the Stanford Programming Competition in spring 2011. This clearly indicates strong interest in technology, engineering, and programming among students, yet students who want to take advanced computer science courses are currently directed to the local community college.

Table 1: High School Computer Science in California's 10 Largest Public School Districts

District	Enrollment	"a-g" CS courses (all "g")	Non "a-g" CS courses (mostly CTE)	CS Graduation Requirement
Los Angeles Unified	687, 534	AP CS; Exploring Computer Science	Digital Computing; Information Processing; Internet Publishing; Intro to Computers; Web Development and Production; New Media; Computer Networks; Computer Architecture Systems; Computer Programming; IT in a Global Society; Computer Literacy	Yes – Applied Technology credits (2 semesters of CS, Health, Home Ec., Industrial Ed, or Business), computer literacy as well (met by taking a course in grades 6-12 or through a test)
San Diego Unified	132, 256	Computer Science 1,2 (Basic programming, Java); 3,4 (Project design and analysis, post AP CS); Website Design; AP CS A	Computer Applications 1,2	Yes – "Computer Literacy" (may be met through courses from grades 5-12). One year-long CTE course requirement added for class of 2016
Long Beach Unified	87, 509	Computer Programming 1-2, 3-4; AP CS	Computer Applications 1, 2; WWW Publishing 1, 2	Computer Applications 1 (unless student has received a C or better in Intermediate Computers in middle school)
Fresno Unified	76, 621	BASIC, AP CS A, AP CS A/B	Computer Skills; Computer Applications; Multimedia	No
Elk Grove Unified	62, 172	AP CS A, Computers and Graphic Design (art), Visual Basic, Computer I, II, Advanced Programming	Computer Applications (Adv.); Computer Technology; Computers (Int.); Computer Networking; Computer Programming; C++ Programming; Computer Science A; Visual Basic; Web Design and Development; Web Design (Int.)	1 semester or proficiency in technology

District	Enrollment	"a-g" CS courses (all "g")	Non "a-g" CS courses (mostly CTE)	CS Graduation Requirement
Santa Ana Unified	57, 439	No classes	No classes – all CS/IT opportunities are through central county ROCP	No – "The technology requirement shall be met through a District-approved demonstration of technological competence." (Imbedded in other courses not a specific course).
San Francisco Unified	55, 183	Computer Applications 1,2; AP CS A; C++ Programming, Computer Programming 1,2; Robotics	Web Design, Multi-Media	No
San Bernardino City Unified	54, 727	Computer Science 1B, AP CS	Computer Literacy, Cisco Certification, Intro to Game Programming, Microsoft Office Specialist, Adobe Certification,	No – used to have computer literacy
Capistrano Unified	52, 681	AP CS A	Not being offered due to lack of enrollment or offered through ROCP via Laguna-Capistrano ROCP	No – College and Career Planning is closest thing
Corona Norco Unified	52, 138	AP CS A	Introduction to Computers, Computer Applications, Advanced Computer Applications/Web Design	Yes/No – "proficiency in the use of computer technology – w/in designated core and elective coursework"

Notes related to the preceding table:

- In 2008-2009 LAUSD had only 1,376 students receive a–g credit for computing courses. A total of 51,605 students took computing courses so only 2.7% received college prep credit.
- Some districts offer additional computing courses through Regional Occupation Center Programs.
- CDE does not presently possess information on which districts have a computing or technology graduation requirement.
- Districts are increasingly linking their high school graduation requirements to the UC requirements for admission ("a-g" requirements) including Los Angeles, Oakland, San Jose, and others. These requirements are more rigorous than the state high school graduation requirements.

2.6 Common Core Standards and Computer Science

The Math Common Core Standards (CCS) also has possible links to computer science. For example, the math standard for practice number 5 focuses on using appropriate tools

strategically. It states, "When making mathematical models, they (students) know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data." The CCS also refers to graphing tools, spreadsheets, computer algebra systems and geometry software to facilitate modeling.

The set of high school courses also includes statistics and probability, which focus on modeling and data (two areas with strong potential connections to computer science). As the course description reads, "Technology plays an important role in statistics and probability by making it possible to generate plots, regression functions, and correlation coefficients, and to simulate many possible outcomes in a short amount of time." [xx]

It is important to note, however, that many policy makers and district leaders may not see the connections between math and computer science with respect to the Common Core Standards. The CCS only mentions the words "computer science" once and that is in an appendix. This has implications not just for California, but for all of the states that have adopted the Common Core Standards (44 out of 50 have adopted at the time of this report).

2.7 Conclusions

- The vast majority of UCOP a–g approved courses have the "g" elective designation. Although there have been considerations to pursue approvals for computing courses as "d", "e", or "h" courses, the clear indications from UCOP are that "c" and "g" are the appropriate places for computing courses and that they would like to "prevent" new categories ("h") from being made.
- The chances of adding a new "h" designation are slim in the current financial climate as such a change would have implications for expenditures at the state level. In addition, the low numbers of students currently meeting "a-g" requirements make it unlikely that additional requirements would be added.
- Although some innovative approaches to including more computer science via "d" and "e" have been proposed, it does not appear that UCOP supports these efforts.
- As Table 1 shows, there are many computing courses that are being taught that do not receive "a-g" credit and therefore students may be receiving only career readiness and not college preparation. Exploring Computer Science is one of only two computing courses that receive "g" credit in LAUSD.
- Facilitating the statewide adoption of a course such as ECS requires considerations about Program Status. Program Status makes it easier for districts to adopt a course because it saves them from having to submit each course for UCOP approval. Instead, districts could work together on establishing shared courses rather than continuing the patchwork of courses that currently exists across the state.
- Current legislative and UC support for partnership academies and CTE at school sites shows that CTE is a way to engage and motivate students so that they complete high school and are prepared for college. CTE route offers opportunities for funding and curriculum to support computing education. Enabling computer science to tap into these opportunities, however, would require that related groups (CPA, NAF, Linked Learning/ConnectEd) also support blending career and academic pathways.

Section 3: CREDENTIALING

3.1 Introduction

Teachers are a critical element of the equation to engage students in computer science and other STEM fields via meaningful learning experiences and courses. Without a skilled, stable, and credentialed teacher workforce, the STEM related fields in California will continue to fail to produce the needed numbers of highly skilled workers. Statistics gathered in 2011 by the Commission on Teacher Credentialing (CTC) show an 8% decrease in the number of newly credentialed teachers, from 2008-09 to 2009-10 (data have not yet been released for 2010-11). Further, there has been a decline from 25, 879 teacher candidates earning credentials in 2005-06 to 20,032 in 2009-10 for a 23% decrease over four years. [xxi] The fiscal pressures on school districts have also resulted in teacher layoffs, as districts seek to balance budgets through workforce reductions and class size increases. These factors impact computer science and other STEM fields more negatively because these teaching positions are already hard to staff, especially in under-resourced areas where the students with the fewest opportunities live. There is a clear and urgent need for changes in the credentialing structure related to computer science and for new pathways for future computer science teachers.

3.2 Overview of Credentialing

The California Commission on Teacher Credentialing (CTC) is an agency in the Executive Branch of California State Government. It was created in 1970 by the Ryan Act and is the oldest autonomous state standards board in the nation. The CTC oversees the licensing and credentialing of professional educators in the State, the enforcement of professional practices of educators, and the discipline of California credential holders.[xxii]

According to CTC, California universities prepared 81 percent of the newly credentialed teachers in California during 2009-10. Teachers prepared in other states who became credentialed in California comprised 18 percent of newly credentialed California teachers. The remaining 1 percent of teachers were prepared through school district intern programs.

Of the three university systems in California—California State University (CSU), University of California (UC), and Private/Independent universities—CSU campuses prepared 52 percent of the new teachers in fiscal year 2009-10. Private/Independent universities prepared 42 percent, and UC programs prepared 6 percent of the new teachers. [xxiii]

3.3 Credentialing and Teacher Assignment

In general, elementary grade teachers receive a multiple subject credential. Those who teach at grades 7-12 receive a single subject teaching credential. California Education Code section 44257 stipulates the allowable subjects for a single subject teaching credential. They are as follows.

44257. (a) The commission shall issue single subject teaching credentials only in the following subjects:

1. Agriculture
2. Art
3. Business
4. English
5. Foreign Language
6. Health Science
7. Home Economics
8. Industrial and Technology Education (ITE)
9. Mathematics
10. Music
11. Physical Education
12. Science
13. Social Science

Holders of valid teaching credentials may add supplementary authorizations to an existing credential by verifying completion of additional coursework in specified content areas (twenty semester units or ten upper division semester units) or based on a degree majoring in the subject(s) to be named on the credential.

In addition, there is a CTE Designated Subjects Teaching Credential which authorizes the holder to teach the appropriate industry sector courses in grades 12 and below, and in classes organized primarily for adults in technical, trade, or vocational courses with employers being responsible to ensure that the placement is appropriate based on the teacher's experience. Work experience is the key factor of this credential as these credential holders ideally are able to share experience from the field with their students in relevant, practical, and meaningful ways.

The *Administrator's Assignment Manual* describes how employing agencies may assign teachers based on the various credentialing options. The local assignment options available in the Education Code were designed to provide flexibility to the employing agency. It legally authorizes the assignment of teachers outside of their credentialed subject area if the specific criteria for each code are met. The majority of these options in the Education Code require academic units, authorization by the district governing board, and teacher consent. Local agencies can use these credentials at their own discretion. Additionally, schools can hire teachers on an internship credential, short-term staff permit, provisional internship permit, or waiver.

3.4 Computer Science and Credentialing

Table 3-1 provides an overview of who is qualified to teach computer science in California public schools.

Table 2: Credentials and Who Can Teach Computer Science in California

Single Subject Credential	Supplementary Authorization	Designated Subjects CTE Credential	Local Assignment
Teachers who hold a single subject credential in: • Math • Business • Industrial & Technology Education (ITE) Typically obtained through a teacher-education program.	Teachers who hold a supplementary authorization in Computer Concepts and Applications (in addition to a single subject credential in any subject). Obtained through coursework.	Teachers with at least 3 years of work experience in the IT field, a high school diploma, and sponsorship from a CTC approved agency. Completion of an approved program needed for a clear (non-provisional) credential.	Teachers who have an undergraduate degree in CS or a sufficient number of university credits in CS may obtain local district authorization. Waivers and board of education permits, etc. may also be part of this qualification.

California computer science teaching credentials occupy an ambiguous space. Title 5 §80005(a) stipulates that computer science courses be taught by a teacher with a Math, Business, or Industrial & Technology Education (ITE) credential or a teacher with a credential in any subject area who has a supplementary authorization specifically in Computer Concepts and Applications.

According to the CTC, the general use of computers (supplementary authorization) includes software evaluation and selection, hardware operations, and classroom use of computers. Computer concepts and applications are related to Business, computer technology is under ITE and computer science is under Mathematics.

The coursework required to obtain a credential in Mathematics includes courses in computer science and/or related mathematics courses such as:

- Discrete structures (sets, logic, relations and functions) and their application in the design of data structures and programming;
- Design and analysis of algorithms including the use of recursion and combinations; and,
- Use of the computer applications and other technologies to solve problems.

The Business credential requires knowledge of terminology, principles and procedures related to the ethical use of information technology. Candidates are prepared to apply principles and procedures related to applications, networking systems, and basic concepts of programming and systems development in business situations.

The basis for the ITE subject matter requirements and standards is a core of study that establishes the "nature of technology." The core is surrounded by the following content areas:

- Power and energy,
- Information and communication, and
- Project and product development.

Prospective teachers study the relationships and principles using different technologies. Further, each of the content areas overlaps with different industry sectors such as engineering and design.

Although these classifications suggest that someone with a credential in Business should only be teaching courses in computing concepts and applications and someone with a credential in ITE would only teach courses such as computer repair, the classroom reality is not so clear cut.

3.5 Computer Science and Teacher Assignment

The *Administrator's Assignment Manual* indicates that since January 31, 2001 employing agencies must assign an individual who holds a credential, teaching permit, or waiver in one of the three broad subject areas. If a class covers the general use of computers, the teacher can hold the supplementary authorization in Computer Concepts and Applications. If a potential teacher has an undergraduate degree or 32 upper division credits in computer science, they can qualify for a subject matter authorization in computer science through the local district or county office of education.

When assigning a teacher for specific courses in computer science or education, the local employing agency has the flexibility to hire the holder of a credential in Business, Mathematics, Industrial Technology Education (ITE) or the with a supplementary authorization in Computer Concepts and Applications. Employing agencies determine if a teacher holding one of the credentials or authorizations noted above have the requisite knowledge and skills for the specific type of computer science or education course offered in their district as long as the course falls within the grade and/or content level limitations noted for that credential or authorization. Ultimately, the local education agency determines how each particular class, as conducted in its district, supports its course of study for grades 9–12. The local governing board decides whether a course is awarded specific graduation credit. In making this decision, the local board may consider the district's course outline in conjunction with the academic content standards and framework. In short, the local agency and not CTC make these determinations.

Some teachers who only have a supplementary authorization in Computer Concepts and Applications with a single subject credential in foreign languages or social studies may be teaching computer science courses even including AP CS. For example, of 27 teachers who have recently been involved with Exploring Computer Science in LAUSD:

- 13 have a Math credential,
- three (3) have a Business credential,
- two (2) have an ITE credential
- four (4) have a supplementary authorization in Computer Concepts and Applications, and
- five (5) do not have any of the relevant credentials in computing,

The 14 teachers involved with ECS in the San Jose area (SJUSD, SCUSD, and ESUHSD) are all math credentialed.

This complicated credentialing arrangement for computer science has a number of consequences. According to reports from CSTA, teachers with a credential in Mathematics are often pulled from their computer science classrooms to teach remedial courses in their primary certification areas, while less experienced and less knowledgeable teachers are assigned to teach the computer science courses or the computer science courses are cancelled altogether. This is particularly true in lower-socioeconomic areas, which are more difficult to staff and often have lower achieving schools. Additionally, in the present fiscal crisis, teachers who have Business or ITE credentials are not as valued as teachers with a Math or Science credential; this results in job losses and the elimination of computer science courses, significantly reducing opportunities for California's students. [xxiv]

3.6 Career Technical Education and Credentialing

A further complication to computer science credentialing is the fact that computer science courses fall both within the academic college preparatory space as well as the CTE space, which is typically associated with vocational education. The ways in which local agencies categorize the respective computing courses determines the particular credential needed by the teacher. Computer science courses may be considered primarily as academic courses but could also be setup as a career technical, trade or vocational courses. Courses with a CTE designation fall under the CTE industry sector of Information Technology. Additionally, Title 5 §80004(c) clarifies that holders of Single Subject Teaching Credentials in specific single subject areas (agriculture, business, home economics, industrial arts, and industrial and technology education) are also authorized to teach trade, technical, and vocational classes within their authorized subject area.

3.7 Alternative Credential Programs Related to STEM

Due to the great demand for STEM teachers and the looming shortage, educational leaders across the state are working to increase the number of STEM teachers. The CalSTEM Pipeline Initiative was created in early 2010 as a direct pipeline into education for potential math and science teachers. College Track, the EnCorps Teachers Program, The New Teacher Center, The Santa Clara County Office of Education, and The San Diego County Office of Education have come together to complement existing avenues of teacher preparation with an apprenticeship for those teaching math and science in underserved areas. According to the California Teacher Corps website, in past years, 50% of California's new math teachers were placed from alternative certification programs. These programs could serve as partners in the preparation of computing teachers by directing candidates to computer science or by developing and supporting courses and resources.[xxv]

3.8 Credential Issues Related to "A-G" and NCLB

CTC has no authority over the graduation credit earned for a course or the "a–g" credit awarded to a course by the University of California. Furthermore, the Commission has no purview over compliance with No Child Left Behind (NCLB). NCLB compliance is a federal requirement that each local employing agency must meet. The NCLB Act of 2001

reauthorized the Elementary and Secondary Education Act (ESEA) of 1965. The federal law requires states to develop assessments linked to teacher quality. All public school teachers with primary responsibility for direct instruction in one or more of NCLB's core content areas are required to demonstrate that they satisfy the definition of a "Highly Qualified Teacher" (at the middle- and secondary-level, this includes Math and Science teachers). NCLB didn't change the state's teacher credential programs, but rather created a problem for teachers who were assigned to teach courses for which they were not credentialed (which happens all the time, particularly as districts downsize their teaching force).

In response to the requirements of NCLB for highly qualified teachers, California developed the subject matter authorization that is equivalent to the coursework required for a second bachelor's degree completed while a student is earning the initial bachelor's degree. An Introductory Subject Matter Authorization authorizes the holder to teach the subject matter content typically included in curriculum guidelines and textbooks approved for study in grades 9 and below. This allows an employer to assign a teacher with an Introductory Subject Matter Authorization to teach a class in which the curriculum is for grades 9 and below but the students in the class may be in higher grades (10-12).

Candidates for an Introductory Subject Matter Authorization must satisfy the following requirements.

1. Possess a valid prerequisite teaching credential, and
2. Complete one of the following:
    a. 32 semester units (48 quarter units) of non-remedial course work;
    b. a degree from a regionally accredited college or university in a subject directly related to the subject to be listed on the credential.

3.9 Changing the Current Computer Science Certification Arrangement

Due to the secondary status of computer science in California's credential structure, some in the computer science education community have expressed interest in pursuing a single subject computer science teaching credential. This would require involvement by the state legislature, CDE, and CTC because California Education Code Section 44257 would need to be revised to add to the 13 statutory subject areas listed in section 3.2. According to a source at CDE this would be a "tall order" and would be difficult in the current fiscal climate.

The first step needed to create a computer science credential involves legislation from Sacramento followed by an advisory commission and State Board of Education action. As part of this process, CDE would have to develop content standards and frameworks for computer science students from which CTC would develop new credential program standards.

If a single subject credential in computer science were to be developed, pre-service teachers would need to complete appropriate coursework (which would need to be defined). In addition, current teachers would need to verify subject matter competence

either by exam (which would need to be developed) or a program of study (which would also need to be defined) or by a grandfathering arrangement (such as Texas currently uses) that would take previous teaching experience into consideration.

Approval of a new credential would also require a documented need by the employer community and proof that the current credentials are not sufficient to meet industry needs. Proving that the current credentials do not include required content would support the contention that the current arrangement must be changed. According to a source at CTC, CDE is collecting lists of classes currently being taught in high school to act as samples to help develop content standards that CTC can use to develop a credential program, however nothing can move forward to enact official changes without legislation.

3.10 Experimental Credential Program

CTC has an experimental program proposal that could be exploited in the absence of new legislation. This program allows a university to present a course of study for potential candidates and describes a reasonable research project that candidates can complete. CTC approval for such a course of study for computer science would enable a university to develop a single subject credential program for a seven-year term that could be used to inform legislators of the uniqueness of teaching and learning in computer science in support of further legislation. An experimental program would operate the same way that the ASL bilingual education credential has operated in the schools for the Deaf. This was an experimental program that started 15-20 years ago which CTC is working to transition to regular program standards.

The Experimental Program Standards found in *Standards of Quality and Effectiveness for Experimental Educator Preparation Programs* (a CTC handbook written in 2008) were designed to invite innovation. They exempt a program from all program requirements except the candidate competency recommendations and any tests required of candidates with similar credentials. Single Subject professional preparation programs must incorporate the Teaching Performance Expectations (TPEs) and the Teaching Performance Assessment (TPA) to ensure that no graduates hit the classrooms without having demonstrated their capacity to teach and to work with students with disabilities or English learners.

It could be very difficult in this present climate for someone to complete an experimental single subject credential in computer science and find a full time teaching job. An experimental credential as part of a dual credential program in which students simultaneously obtained a single subject credential in math or science and the experimental credential in computer science would make teacher candidates more attractive to employers.

3.11 Conclusions

- According to a source at CTC, they are constantly receiving e-mails from future teachers and organizations inquiring as to whether California has a computer science or computer engineering credential. The current emphasis on STEM also

makes this a very favorable time to push for changes to teacher credentialing that would be supportive of computer science education.

- The development of a computer science credential, whether experimental (a dual Math/ Computer Science or Science/ Computer Science) or a full-fledged single subject credential, requires a compelling justification. It would require a detailed explanation of how the current situation is inadequate with respect to the preparation teachers are receiving in computer science and the development of content specific pedagogy classes. Subject matter standards and domains would also need to be developed.
- CTC wants to support an Experimental Program in computer science, as it would enable the development of a model that legislators and state leaders could learn from. This process would also lay the groundwork for developing the content and pedagogy a computer science credential would entail.

Section 4: PROFESSIONAL DEVELOPMENT

4.1 Introduction

Professional learning and development opportunities for California computer science educators are limited but increasing. Sources include CTE training for particular high school computer science courses, the Computer Science Teachers Association (CSTA), industry-supported events, online resources, and externships. These sources provide more opportunities for computer science teachers than existed 5-10 years ago. Unfortunately, however, there is little overall coherence to the professional development (PD) landscape. It exists in localized pockets that do not cover much of the state. In addition, these opportunities are often poorly publicized and so potential educators who could benefit are unaware of them.

In professional development, the differences between CTE/IT and computer science are also problematic. A CTE director at a major district in California indicated that, "IT instructors are provided 2 common IT full PD days annually, and 2 CTE Community Meetings. They are also expected to partake in at least 2 additional PD days, but have up to 20 days of PD to select from. Computer science teachers, outside of their school site based PD, do not receive specific PD." CTE/IT teachers qualify for a variety of restricted funds that CS teachers do not (federal Perkins, state ROP, Proposition 1D facility and improvements, etc.).

4.2 State Level Programs

State supported professional development for computer science teachers occurs within the context of CTE and the IT pathway. The 2008-2012 California State Plan for CTE provides general parameters for each of the 15 sectors. In CDE, each sector is assigned "leadership funds" that can be used to support the sector under the direction of a sector lead. These funds, however, are greatly limited due to the state fiscal crisis.

Funds are also available for other initiatives that benefit the IT sector. CTE Online (www.cteonline.org) is an online repository of teacher created model lessons and resources, produced by the Butte County Office of Education with CDE funds. Teachers were enlisted to attend a two-day Model Curriculum Institute training and then paid $1,000 for writing four engaging, standards aligned lessons. As a result of this event, the CTE Online website now has Web Page Design Model Lessons and Intro to Programming Model Lessons. These resources may serve as professional curriculum development and learning tools for educators. Additional Model Curriculum Institutes will be held during the 2011-12 school year.

Additional state level PD related support comes from engagement with partners and dissemination of resources. Partners include organizations like the World Organization of Webmasters (WOW) see: http://whyitnow.org/advocacy and MPICT http://www.mpict.org/. Other work involves distributing information through a listserv for the teaching community (primarily high school level).

4.3 Perkins Funding and Professional Development

Perkins funding is also available for professional development. Perkins IV requires local education agencies receiving these funds to provide professional development to CTE teachers, faculty, administrators, and career guidance and academic counselors. As noted in Section 135 (b)(5) of the Perkins Act, professional development activities funded by Perkins funds must be consistent with the instructions provided in Section 122 of the Act for preparing the State Plan. The following required professional development activities are excerpted from Subsection (c)(2) of the State Plan instructions, which stipulate that comprehensive professional development activities provided for CTE teachers, faculty, administrators, and career guidance and academic counselors must:

- Promote the integration of coherent and rigorous academic content standards and CTE curricula through opportunities for the appropriate academic and CTE teachers to jointly develop and implement curricula and pedagogical strategies, as appropriate;
- Increase the percentage of teachers that meet teacher certification or licensing requirements;
- Be high quality, sustained, intensive, and focused on instruction, and increase the academic knowledge and understanding of industry standards, as appropriate, of CTE teachers;
- Encourage applied learning that contributes to the academic and career and technical knowledge of the student:
- Provide the knowledge and skills needed to work with and improve instruction for special populations;
- Assist in accessing and utilizing data, including data provided under Section 118 (occupational and employment information), student achievement data, and data from assessments; and
- Promote integration with professional development activities that the state carries out under Title II of ESEA of 1965 and Title II of the Higher Education Act of 1965.[xxvi]

While, as noted above, the act describes the type of professional development activities that must be provided in programs assisted with the funds, it does not require that Perkins funds be used to provide the activities. Nor does it specify the percent of the local agencies' Perkins funds that must be used to support the activities.

Section 135(b)(5)(C) of the Act requires that CTE teachers, faculty, administrators, and career guidance and academic counselors involved in the CTE programs assisted with the local agency's Perkins funds be provided with program-related internships that provide relevant business experience, but it does not identify specific guidelines for the type or duration of these experiences. Local agencies and districts are encouraged to discuss the issue with their respective industry advisory committees to:

1. Determine the recommended in-service of the respective educator groups; and
2. Work out the details as to how, when and where the internships will take place. Perkins funds may be used to support necessary and reasonable cost related to these activities.

4.4 College Board APCS Institutes

As part of its support for Advanced Placement courses, The College Board offers AP Computer Science workshops for teachers. According to the College Board website, Summer Institutes "offer 30-plus hours of subject-specific professional development that equip K–12 teachers with content and resources to enhance their teaching of AP courses. They also provide an opportunity for teachers to exchange ideas and information with peers worldwide, and to become a member of an extended learning community." Summer institutes cost $650, which likely inhibits participation for teachers who cannot obtain funding through their school (most schools no longer provide professional development funding). Very few College Board AP Computer Science workshops are now being offered, with only one currently scheduled in California for 2012.

Additional opportunities for PD related to AP CS include an Electronic Discussion Group sponsored by the College Board that is available at no cost and serving as a reader for the exam with associated learning opportunities. There are no online training opportunities presently available.

4.5 Exploring Computer Science

Professional development is provided for Exploring Computer Science teachers in Los Angeles and San Jose throughout their participation, supported by NSF grants. This professional development focuses on content and pedagogy that pertains to the teaching of ECS, while also providing an opportunity to participate in a professional learning community.

In Los Angeles, the ECS team holds an annual summer multi-day institute supported by Saturday follow-ups during the school year. During the last week of June 2011, 27 experienced and new ECS teachers from LAUSD came together to learn about the ECS curriculum, purposes of the course, and pedagogy to engage diverse learners, along with other relevant topics. The summer professional development is followed up by three-four Saturday sessions that continue the learning and community building throughout the school year. The grant also provides the teachers with a generous stipend for their participation and supports coaches who visit teachers' classrooms during the school year.

A separate project in San Jose has provided summer workshops and Saturday follow-ups for 14 teachers from three school districts since the summer of 2010. Each of the 10 participating schools has received equipment and financial support, and teachers have received stipends. Rather than coaches, however, the San Jose team provides computer science graduate students who assist teachers in their classrooms for 15 hours per week throughout the academic year.

4.6 Computer Science Principles

Various instantiations of CS: Principles courses are being piloted at approximately 15 universities across the country, and these institutions are currently working with local high schools primarily within their region to spread the curriculum. This obviously requires professional development for the high school teachers. Within California, three

universities are currently providing CS: Principles professional development.

UC Berkeley delivered an eight-week professional development CS: Principles tutorial for teachers in Summer 2011. The course was primarily distance education, but started with a face-to-face, weeklong prologue and culminated with a face-to-face, weeklong epilogue. The course required approximately 24 hours work per week. Twenty-nine teachers enrolled, but due to the heavy workload only ten finished the course. This course was a pilot for a "train the teachers" effort that UC Berkeley is now pursuing with funding from NSF's CE-21 program to provide professional development to 100 teachers across the United States. The CE21 funding will expand existing teacher outreach and professional development efforts. The professional development model is not limited to a single short-term intervention, but includes two weeklong summer workshops with online course activities between them, strong support for participants' curriculum adoption during the following school year, and a follow-up session the next summer for participants who will run the next iteration of teacher preparation.

Stanford University offered a two-day CS4HS workshop in Summer 2011, which in part focused on CS: Principles. Thirty teachers attended (an additional 60 expressed interest but could not be accommodated). The laboratory portion of the workshop was an accelerated, hands-on exercise based on the CS: Principles curriculum now being taught at Stanford in the 2011-12 academic year.

UC San Diego did a one-week professional development session for five San Diego high school teachers in Summer 2011. Four of these teachers are implementing some aspects of CS: Principles in their classes this year. UCSD faculty and staff will be following up with two-three hour support meetings once per quarter, and they host a weekly half-hour conference call with the teachers. More extensive professional development is planned for San Diego teachers next summer.

4.7 CSTA and Professional Development

The Computer Science Teachers Association, as the preeminent association for K-12 computer science teachers, offers professional development opportunities in California through participation in its four regional chapters and its annual CS&IT conference. There are currently 575 California members of CSTA including middle school teachers, high school computing teachers, college/university computer science faculty and education faculty, and members from industry interested in supporting computer science education and teachers.

CSTA has four chapters in California: Golden Gate, Silicon Valley, Southern California and San Diego. CSTA organizes annual training sessions for chapter leaders each year but attendance is limited due to travel costs. A volunteer chapter liaison works with chapters to help them organize and stay on track. Chapters are encouraged to pursue the same national goals of CSTA as well as their own local goals and activities. A snapshot of each of the four California chapters is provided below:

San Diego chapter:

- Partnership with the UCSD San Diego Supercomputer Center providing an opportunity to introduce CS course work to all San Diego County high school students
- Piloting AP CS: Principles course with associated training
- Planning to meet four times a year with a summer event
- Looking to eventually expand into extra-curricular areas such as contents for mobile computing, robotics and web design

Southern California chapter:

- About 20 active members
- Meetings include a "best practices" discussion, including helpful websites
- Two members are part of the AP CS: Principles course that is in development, and several of their members are AP CS readers
- Members report on CS conferences they have attended

Silicon Valley chapter:

- This has been the most problematic of the California chapters due to chapter leadership issues.
- About 20 people at the most recent meeting with a mailing list of approximately 200 but few of the meeting attendees are public high school teachers
- No active 'projects' at this time
- Most recent meeting featured a presentation by Emmanuel Schanzer, who is the founder of Bootstrap, which is connected to his graduate work at Harvard in connecting CS and math curricula. Meeting at Facebook headquarters

Golden Gate chapter:

- About 75 members on the chapter's Google groups (not all CSTA members)
- Monthly meetings with participants ranging in number from 15 to 25 at each meeting
- Each meeting includes at least one staff development presentation or report from a member or a guest speaker

CSTA's premiere CS professional development event is its annual CS&IT Conference. When it is located in California it attracts a sizeable number of California CS teachers. In 2010, CS&IT was held at Google headquarters in Mountain View, CA. 120 teachers or 63% of total participants were from California. CSTA works in partnership with the Anita Borg Institute to provide an annual workshop focusing on equity at the Grace Hopper Celebration of Women in Computing. It also partners with other institutions and organizations on local events such as the Computation Thinking workshops and the Tapestry workshops.

4.8 Computer Science for High School (CS4HS)

CS4HS (Computer Science for High School) is an initiative sponsored by Google to promote computer science and computational thinking in the high school and middle school curriculum. Google's Education Group provides awarded universities with a $15-20K grant

to develop two–three day workshops for high school and middle school computer science teachers. These workshops incorporate informational talks by industry leaders, and discussions on new and emerging CS topics. In 2010, UC Berkeley and UCLA were awarded CS4HS grants. In 2011 Harvey Mudd, Cal Poly San Luis Obispo, Stanford, UC Berkeley, and UCLA were awarded grants.

A brief summary of details related to CS4HS programs provided in 2011 by each university follows:

UC Berkeley:

- 38 K-12 teachers attended a two-day program in June.
- Included workshops on Scratch and Snap, CS Unplugged, participation in computing, App Inventor, and teaching tips.
- Aligned with local CSTA chapter to promote continued collaboration.

Stanford:

- A two–day program held in July attended by 30 teachers.
- Presentations included a programming lab taught by Nick Parlante (Stanford lecturer, Google instructor, creator of CodingBat and Nifty Assignments), a preview of AP CS: Principles pilot course (discussed above), a session on probability and computing, and Google's Educational Initiatives.

Harvey Mudd:

- Focused on middle-year teachers (middle school and early high school).
- 8 teachers attended a four-day program in July.
- The program covered the first four units of ECS (calling it MyCS).

Cal Poly:

- Offered a two–day program in June called "Computing is Everywhere!"
- 45 people registered to attend.
- Labs included beginner computing environments, computing in disciplines, App Inventor, programming music and coding games with Flash/Actionscript.

UCLA:

- Will hold four events during the 2011-12 school year.
- Events will focus on the following topics: Scratch, robotics, stereotype threat and CS, increasing CS awareness among school counselors and principals.
- Anticipate 25-30 teachers attending each event (with exception of administrator focused one).

The CS4HS workshops provide a useful model for connecting K-12 educators and post-secondary computer science faculty. CSTA currently works with a small number of the CS4HS sites, providing them with materials and outreach advice. A more formal connection between CSTA and these Google-sponsored sites would ensure a closer link between workshop content and computer science learning standards and could provide an opportunity for extending these learning experiences over a longer period (following ECS's model).

4.9 Industry Related Professional Development

Beyond the Google-sponsored CS4HS programs there is very little industry-sponsored professional development for computer science teachers. Apple and Google do offer a Distinguished Educator and Teacher Academy program but these are oriented toward educational technology rather than computer science. Intel provides webinars on integrating technology and HP has a teacher exchange but again these programs are not really relevant for computer science educators. Microsoft's "Faculty Connection" website also offers a number of resources that could be of use to CS teachers including sections on Operating Systems, Programming, Security and Windows Phone 7. Industry-related resources and professional development, however, tends to focus on promoting applications and resources produced by the supporting company rather than on supporting the teaching and learning of computer science concepts.

4.10 Additional Opportunities

In addition to the numerous professional development opportunities outlined above, computer science educators can take university/college courses, engage in online learning programs, or take advantage of industry partnerships.

Stanford, for example, is offering some of its most popular engineering classes free of charge to students and educators around the world via its Seeing Engineering Everywhere (SEE) website. This website includes lecture videos, access to reading lists, and other course handouts (http://see.stanford.edu/default.aspx). SEE programming includes one of Stanford's most popular sequences: the three-course Introduction to Computer Science taken by the majority of Stanford's undergraduates and seven more advanced courses in artificial intelligence and electrical engineering.

UC Berkeley provides access to videos and notes for CS 10 (The Beauty and Joy of Computing) among other classes. In addition, there are an abundance of resources through the UC Berkeley Self-Paced Center website including online study guides and resources for courses such as Java, Python, and Scheme. The UCB Electrical Engineering and Computer Sciences course website (http://www-inst.eecs.berkeley.edu/classes-eecs.html) website also provides a plethora of course-related materials.

In addition, university centered groups such as Industry Initiatives for Science and Math Education (IISME) offer professional development resources. IISME was founded in 1985 by a consortium of San Francisco Bay Area companies in partnership with the Lawrence Hall of Science at the University at Berkeley. According to its website, "IISME seeks to transform teaching and learning through industry-education partnerships. We provide teachers with experiences and tools they need to adapt their practices and change their schools so that all students are prepared to be lifelong learners, responsible citizens, and productive employees." The summer fellowships are paid (up to $8,200) and typically involve teachers with an average of eight years of experience.

IISME tracks the number of Fellows by subjects taught, degrees held, etc. The chart below offers a snapshot of the percentage of CS/tech teachers relative to the larger group of IISME

Teacher Fellows for the past few years; the subjects taught and degrees held do not necessarily correspond.

Table 3: IISME Fellows

Year	# of Fellows Teaching Computer/Tech Courses	# of Fellows with Degrees in Computer Science	# of Fellows with Degrees in Instructional Technology	Total # of Fellows
2010	19	8	10	142
2009	16	8	13	120
2008	24	6	13	178
2007	40	9	14	187
2006	61	5	6	191

Although IISME has traditionally focused on partnerships in Northern California they recently expanded to the Los Angeles area in the summer of 2011, and are looking to spread to Orange County in 2012.

4.11 Conclusions

- California's emphasis on local control results in a complicated assortment of offerings that prevent statewide coherence with respect to computer science teacher preparation, professional development, and support. Apart from the CTE umbrella, the state is not involved in any computer science-specific efforts. In addition, much of the funding for professional development is embedded in CTE and depends upon CTE funding sources.
- The Computer Science Teachers Association provides a unique opportunity for a statewide effort to bring teachers together as a learning community in similar ways to other organizations such as the California Teachers of English. While there is significant potential for growth (most of the California chapters are newly formed) chapter meetings tend to be small (20-25 teachers) and chapters struggle to provide services with little to no funding.
- With the exception of Google and Microsoft (both of whom support the CSTA annual conference), industry leaders are doing very little to support professional development for computer science teachers. This is highly disappointing given the breadth of the industry in California. ACCESS may be able to convince industry leaders to provide funding, host events, or donate services.
- In-person professional development opportunities for computer science teachers are very limited in California, especially for teachers who do not live in proximity to large urban centers. Online opportunities are increasing; however, they lack the community element, which is essential to professional learning communities.

Section 5: FUNDING

5.1 Introduction

This section presents an overview of funding sources in California for public education that support K-12 computer science education. These sources include federal funding associated with the Perkins Grant and Title I-III programs as well as state funding associated with legislative bills (SB 70/1133), propositions (1D), and court settlements (Microsoft and Williams). While none of these programs are specifically designed for computer science education they could potentially be leveraged to support K-12 computer science teaching and learning, particularly through CTE connections to the IT sector. Matching the funding objectives to computer science, however, would require innovative thinking.

5.2 Perkins Funding

The Carl Perkins Career and Technical Education Improvement Act of 2006 (replacing the Carl Perkins Vocational and Technical Education Act of 1998) is a federally funded program approved by Congress to improve CTE programs and integrate academic and career technical instruction for secondary and post-secondary students. Basic Perkins grant funds to California over the last three years were:

- 2011-12: $119,242,094
- 2010-11: $127,991,502
- 2009-10: $128,360,005

Congress requires that 85% of a state's Perkins funds be distributed to local educational agency (LEA) programs, while 15% can be kept at the state level for administration and program support.

There are restrictions placed on LEAs both by Congress (via the Perkins Act) and by the California Department of Education (CDE) regarding how their annual allocation can be expended. Section 135(a) of the Perkins Act identifies "improvement of CTE programs" as the Act's primary purpose, and while Section 135(b) explicitly describes the requirements of LEA programs that can be assisted with the funds, Congress still gives LEAs considerable latitude in selecting the CTE programs they assist and deciding how these funds are used. CDE, however, places additional restrictions on the use of distributed funds, requiring that no less than 85 percent of the LEA's annual allocation be expended for acquisitions and activities (instructional, professional development, curriculum development, and research/data collection) that are directly related to the LEA's selected CTE programs. Moreover, up to 85% of the allocation can be used to support the following expenses:

- Instructor salaries for the first three years of a new program or extended sections of an existing program,
- Stipends for summer internships
- Substitute teacher coverage for teachers participating in professional development activities during the school year,
- Stipends for teacher advisors of CTE student organizations, and
- Teacher release time for articulation activities.

Because each LEA is responsible for the planned use of its funds, there are no specific guidelines for the percent of the local allocation that must or can be expended on the various activities. Furthermore, while the local educational agency has the prerogative of assigning any teacher with a qualifying credential to teach a career-related course, Perkins funds may not be used to assist either the program or the teacher, unless the teacher also has documented evidence of actual employment experience outside of education in the career path addressed by the program and the program also satisfies the other 12 requirements of CTE programs.

5.3 Senate Bill 70 and Senate Bill 1133

In 2005, the *Governor's Initiative on Improving and Strengthening Career Technical Education* was passed as Senate Bill (SB) 70. This legislation allocated $20,000,000 specifically for improving CTE at the community college and secondary level. The bill made CDE an active and full partner in the development of the plan to carry out this initiative. The CDE Career and Workforce Innovations (CWI) Unit provides the leadership in this work. In 2006, the Governor signed SB 1133 to continue this work with additional funding through the 2013-14 fiscal years.

SB 70, as it is commonly referred to, calls for the CWI Unit staff and the California Community College Chancellor's Office staff to regularly meet and plan for appropriate CTE funding priorities. These priorities now take the form of approximately 18 unique CTE proposals and grant opportunities to be funded at both community college and secondary levels. Examples of SB 70 elements include, but are not limited to:

- Building upon existing programs and creating new ones to increase student participation in industry sector CTE programs at the high school and ROCP level,
- Preparing middle schools to offer CTE awareness programs,
- Studying methods of increasing CTE teacher availability from business and industry, and
- Looking at methods to standardize articulation between community college and high school and ROCP programs statewide. [xxvii]

In 2006, Tom Torlakson authored Senate Bill 1133 (SB 1133). This legislation established the Quality Education Investment Act (QEIA) to implement settlement terms of the *California Teachers' Association v. Schwarzenegger* lawsuit. The lawsuit claimed the Governor did not fully fund Proposition 98 in accordance with his 2004 agreement with the education community. In May 2006, all parties agreed to settle the case and support legislation necessary to implement the settlement agreement. Specifically, Chapter 751, Statutes of 2006 (SB 1133) allocated an additional $32 million in 2007-08 and $38 million annually from 2008-09 to 2013-14 to SB 70 to expand CTE in public secondary education and lower division public higher education, including hiring additional faculty to expand the number of CTE programs and course offerings.

Funding from SB 70 and SB 1133 has supported the following areas as part of the Initiative on Improving and Strengthening Career Technical Education:[xxviii]

I. Resources for Educators
    - California Partnership Academy Grants
    - Distance Learning Pilots
    - CTE Community Collaborative Grants
    - Career Advancement Academy Grants
    - CTE Leadership Institute and New Teacher Workshops
    - Project HOPE
    - Youth Entrepreneurship Program
    - CTE Teacher Preparation Pipeline
II. Statewide Resources
    - CTE On-Line
    - a–g Guide Workshops
    - Statewide Career Pathways: School to Community College Articulation
    - Connections to Economic and Workforce Development Program Initiative ("CTE HUB")
    - CTE Articulation with Four Year Institutions
III. Resources for Students
    - The WhoDoUWant2B Campaign
    - Statewide Career-Technical Student Organizations (CTSOs)

Both SB 70 and SB 1133 funds could potentially connect to computer science. Grants for California Partnership Academies (see courses section for more info) were part of the funding opportunities for 2010-11. Specifically up to 50 grants were available for planning and implementation of CPA's at comprehensive high schools. Up to $15,000 was available for a year of planning for implementation in 2011-12 for which an additional $42,000 could be available. Of the 50 grants that were awarded in this cycle, only Computer and Media Pathway at Apple Valley High School was part of the IT sector.

5.4 Title I

Title I provides financial assistance to local education agencies (LEAs) and schools with high numbers or high percentages of poor children to help ensure that all children meet challenging state academic standards. Federal funds are currently allocated through four statutory formulas that are based primarily on census poverty estimates and the cost of education in each state.

Title I is designed to help students achieve proficiency on state academic achievement standards. Title I schools with percentages of low income students of at least 40 percent can use Title I funds (along with other Federal, State, and local funding) to upgrade school-wide instructional programs. Title I schools that have fewer than 40 percent low income students or that choose not to operate a school-wide program can offer a "targeted assistance program" for students who are failing, or most at risk of failing, to meet the State's challenging academic achievement standards. Targeted assistance schools design an instructional program in consultation with parents, staff, and district staff, to meet these students' needs. [xxix]

By state law, School Site Councils (SSC) must oversee the site-based budgeting of categorical funds of which Title I is a part. The SSC represents parents, students, community members, and school staff in the school governance process. Although Title I focuses on the student achievement in the core academic content area, SSCs may determine that a computer science course could serve to help with student achievement in math or other courses. This could lead to allocation of funding to help provide student opportunities for learning computer science or resources to support that effort. According to multiple sources, many schools currently use Title I funds to purchase technology such as computers using various justifications depending on their school plans.

5.5 Title II

Title II, Part A, Teacher and Principal Training and Recruiting, is a federal categorical program. Title II is intended to increase the academic achievement of all students by helping schools and districts improve teacher and principal quality through professional development and other activities, and ensure all teachers are highly qualified.

The Enhancing Education Through Technology Competitive(EETT-C) grant program provides funding for grades four through eight to assist eligible local educational agencies in using technology to enhance teaching and learning under Title II, Part D, of the No Child Left Behind Act. EETT-C is a competitive grant process administered by the Educational Technology Office of CDE. LEAs must complete an application, which is scored and ranked against other competitors. The top scoring applications are funded.

The Enhancing Education Through Technology Formula(EETT-F) grant program provides funding for grades kindergarten through twelve to assist eligible local educational agencies in using technology to enhance teaching and learning. EETT-F funding is based on an LEA's proportionate share of Title I, Part A funds it receives to the state's total.

Elements of EETT funding that may support CS education include:

1. Establishing or expanding initiatives, particularly initiatives involving public-private partnerships, designed to increase access to technology for students and teachers, with special emphasis on the access of high-need schools to technology.
2. Adapting or expanding existing and new applications of technology to enable teachers to increase student academic achievement, including technology literacy:
    A. Through the use of teaching practices that are based on a review of relevant research and are designed to prepare students to meet challenging state academic content and student academic achievement standards; and
    B. Through the development and utilization of innovative distance learning strategies to deliver specialized or rigorous academic courses and curricula to areas that would not otherwise have access to such courses and curricula.
3. Preparing one or more teachers in elementary schools and secondary schools as technology leaders who are provided with the means to serve as experts and train other teachers in the effective use of technology, and providing bonus payments to the technology leaders.
4. Acquiring, adapting, expanding, implementing, repairing, and maintaining existing

and new applications of technology, to support the school reform effort and to improve student academic achievement.
5. Acquiring connectivity linkages, resources, and services (including the acquisition of hardware and software and other electronically delivered learning materials) for use by teachers, students, academic counselors, and school library media personnel in the classroom, in academic and college counseling centers, or in school library media centers, in order to improve student academic achievement.
6. Developing, enhancing, or implementing information technology courses.
7. Purchasing digital equipment and materials to help meet the program's objective.

The California Mathematics and Science Partnership (CaMSP) grant program, administered by the Mathematics and Science Leadership Office in the California Department of Education(which is also under Title II) focuses on increasing the academic achievement of students in mathematics and science by enhancing the content knowledge and teaching skills for classroom teachers through professional learning activities. No Child Left Behind (NCLB) Title II, Part B is the funding source for this in-depth professional development program. Funding began in 2003-04. In fiscal year 2009-10, the California Math Science Partnership program was funded at approximately $20 million. The 2010–11 program is funded at approximately $21 million. [xxx] Representatives from CDE indicated that**,** "Technology or computer science may be a component of the grant, however the primary focus of the professional development must be Earth, Life or Physical science. Typically a science project focuses professional development on all three science disciplines."

5.6 Title III

Title III, Immigrant Education Subgrant Program, funding is made available to eligible local educational agencies (LEAs) to provide supplementary programs and services to eligible immigrant students. The purpose of the subgrants is to assist immigrant students to acquire English and achieve grade-level and graduation standards.

Funding is also made available to eligible LEAs to provide supplementary programs and services to limited English proficient (LEP) students, known as English learners (ELs). The purpose of the subgrants is to assist EL students to acquire English and achieve grade-level and graduation standards.

While computer science is not specifically excluded from Title III, the clear emphasis on English language acquisition makes it unlikely that schools or districts would allocate or approve for funding for computer science courses or computer hardware with these funds. Software for language development is acceptable.

5.7 Proposition 1D Funding

California's Proposition 1D provides grants to eligible schools for improving and expanding their Career Technical Education (CTE) programs. In 2006, Proposition 1D allocated $500,000,000 for this purpose. The measure allows for eligible schools to apply for new construction funding, remodeling and reconfiguration funding and/or funding for CTE equipment. While the language in the legislation is somewhat vague and unclear, the Career

and Workforce Innovations Unit (CWI) provided the leadership in coordinating the State's efforts to create a clear and organized system for the CTE application process. The program calls for a significant planning effort to be made by the school to address all the necessary components for the application. Schools can obtain up to $3,000,000 for new CTE construction, $1,500,000 for remodeling existing CTE facilities and/or purchasing CTE equipment.[xxxi]

Proposition 1D allocates $500,000,000 for CTE purposes, with the first and seconds rounds allocating $420,000,000. The third round allocated $80,000,000 in early 2010. As of August 2011 there was still $28,000,000 left in Prop 1D funding. CWI is contacting the next highest ranked schools that participated in the third round to determine their interest in accessing these funds. As a side note only two of the seventy-seven awarded schools from round three funding had plans that focused on IT. Of the 498 grants awarded in the three cycles thus far, only 13 were from the IT sector. The Arts, Media, and Entertainment sector received the majority of awards (101).

5.8 The Regional STEM Service-Learning Initiative

The Regional STEM Service Learning Initiative was a recent grant opportunity through the CalServe K-12 Service-Learning Initiative out of CDE. It is intended to promote STEM-based service learning opportunities for students, especially female and underrepresented minorities, to increase student interest in pursuing STEM-related careers and postsecondary study. A key focus of the initiative was to better engage participants in the civic lives of their community. A total of seven awards of $40,000 each were made to different LEAs in fiscal year 2010-11. While this program no longer provides funding, it demonstrates CDE's desire to provide meaningful opportunities to link service learning to STEM fields.

5.9 Williams Funding

The *Eliezer Williams, et al., vs. State of California, et al. (Williams)* case was filed as a class action in 2000 in San Francisco County Superior Court. The plaintiffs include nearly 100 San Francisco County students, who filed suit against the State of California and state education agencies, including the California Department of Education (CDE). The basis of the lawsuit was that the agencies failed to provide public school students with equal access to instructional materials, safe and decent school facilities, and qualified teachers.

The case was settled in 2004, resulting in the state allocating $138 million in additional funding for standards-aligned instructional materials for schools in the first and second ranks (known as deciles) determined through the 2003 Academic Performance Index (API) Base. The settlement includes another $50 million for implementation costs and other oversight-related activities for schools in deciles one through three (2003 API Base). These two amounts were included in the state budget signed in July 2004 by Governor Schwarzenegger. Another $800 million will be provided for critical repair of facilities in future years for schools in deciles one through three (2003 API Base). The settlement will be implemented through legislation adopted in August 2004: Senate Bill (SB) 6, SB 550,

Assembly Bill (AB) 1550, AB 2727, AB 3001. Up to 2.3 million California public school students may benefit from funding from the Williams case settlement.[xxxii]

Williams Settlement funds may only purchase standards-aligned, locally adopted instructional materials in the following subject areas:

- History-Social Science
- Science
- Mathematics
- Reading/Language Arts—English-Language Development

Because Computer is an elective, it does not qualify for Williams Settlement funds. Computing courses are also exempt from the requirement to have a textbook for each student as part of the annual "Williams visits" made to target schools.

5.10 Microsoft Education Technology K-12 Voucher Program

Education Technology K-12 Vouchers are the result of the Settlement Agreement between California consumers and the Microsoft Corporation. Districts must use the vouchers to implement and support their state-approved district technology plans for kindergarten through grade twelve. The vouchers can be redeemed for a variety of goods and services and may be used for any computer platform that the school or district specifies. The vouchers are 50% General Purpose Vouchers and 50% Specific Category Software Vouchers.

"Eligible schools" are defined in the Settlement Agreement as all public K-12 schools, county offices of education, direct-funded charter schools, and State Special Schools in which at least 40 percent of the attending students are eligible to receive free or reduced-priced meals through the National School Lunch Program. "Eligible Schools" also include all public high schools in California that serve students from public elementary, middle, and junior high schools at which at least 40 percent of the attending students are eligible to receive free or reduced-priced meals through the National School Lunch Program.

General Purpose Vouchers may be used to purchase specific hardware (listed below), any non-custom software for that hardware, evaluation tools, information technology (IT) and professional development services provided by approved providers.

Specific Category Software Vouchers may only be utilized to purchase specific categories of software (listed below) published or sold by any software provider. Both the General Purpose and Specific Category Software Vouchers may be applied in an amount no greater than the standard academic price, or if an academic price is not available, in an amount not to exceed the normal manufacturer or vendor price. The following list gives examples of eligible goods and services that may be purchased with one or the other category of the vouchers:[xxxiii]

- ***Hardware***
    - Any new laptop, desktop, or tablet computer for any operating system platform.

- Peripheral devices: printers, scanners, monitors, keyboards, pointing devices (e.g., mouse, trackball, interactive whiteboards, LCD projectors that are capable of accepting a data feed from a computer, etc.).
- Equipment needed for networking and infrastructure (e.g., routers, servers, wireless network cards, or wireless access points).
- Hardware for accessing the Internet through television sets and Internet access for such hardware for students' homes.
- Non-custom assistive technology devices for use by students with special needs.

- ***Software***
  Purchased with Specific Category Software Vouchers - Specific categories of software offered by any software publisher or vendor, including:
  - Operating system
  - Word processing
  - Spreadsheet
  - Presentation
  - Desktop relational database oriented towards single users and typically residing on a standard personal computer
  - Web-authoring
  - Productivity and/or Productivity Suite
  - Encyclopedia
  - Server, including client access licenses
- ***IT Support Services***
  Services that primarily involve the maintenance of hardware procured through this Settlement and the installation and maintenance of software procured through this Settlement.
- ***Professional Development Services***
  - Professional development services directed solely at leadership development for school administrators in the use of education technology to improve learning at the site or district.
  - Professional development services directed solely at general curriculum development and instructional strategies, which utilize educational technology to improve instruction.
  - Professional development services directed solely at the improvement of technology integration for any software title acquired through this Settlement.
  - Training in the use of any hardware or software title acquired through this Settlement.
  - Certification training for software and networking.

The deadline for making purchases for voucher redemption is September 25, 2013.
As of August 2011, there were substantial amounts of funds left in many districts' General Purpose Vouchers allocations and even more in their Software Vouchers allocations. According to a source at LAUSD all of the current vouchers have been committed and will be expended over the next year. Furthermore of the past purchases, schools bought computers, laptop computer carts, LCD projectors, and Interactive Whiteboards (in that order). In addition, some district-wide licensing agreements (Database, Antivirus, etc.) were made.

5.11 Conclusions

- The major areas for state and federal funding relate to CTE. These are Perkins funds, Proposition 1D and SBs 70 and SB 1133.
- Federal funding of Title I-III does not necessarily eliminate computer science but apart from Title I they have not been applied to CS/IT. If computer science is perceived as a course to strengthen student achievement in math and science there could be a better case made for funding in those areas particularly Title I, which is a large funding source for most urban schools.
- SB 70, SB 1133 and Proposition 1D provide funding that is not being adequately tapped for computer science. Most allocations made from these sources are to other CTE sectors, with IT being close to the bottom third. This may be due to the embedding of technology into other areas or a lack of applications made for these funds.
- The Community College HS partnerships (SB 70) offer some potential for computer science funding. There are very few strong models in this area related to IT, which would bode well for a well-conceived grant in this area.

Appendix A. Access and Enrollment for Computer Science

The following four tables provide statistics related to the state of computer science access and enrollment in California. All data is for all California Public Schools unless otherwise noted.

Table 4: Grades 7-12 Student Enrollment in Computing Courses

School Year	Student Enrollment: Computing Courses	Student Enrollment: Overall
2008-09	212,059	2,980,037
2003-04	324, 121	2,855,262
1998-99	321,999	2,483,772

Notes: Due to cuts to the student data system, course enrollment numbers for 2009-10 and 2010-11 are not available. Computing courses include: Computer Literacy, Computer Science, Computer Programming, Web Design, Information Processing and other CS and IT related courses. Data provided by the California Department of Education[xxxiv]

Table 5: Demographics of Advanced Placement Computer Science Test Takers

Year	Black	Latino/a	Female	Total
2007	40 / 1.4%	230 / 7.9%	582 / 19.9%	2927
2008	33 / 1.1%	159 / 5.5%	558 / 19.4%	2878
2009	35 / 1.2%	172 / 5.8%	565 / 19.1%	2965
2010	33 / 1.2%	161 / 5.8%	582 / 20.8%	2793

Note: Years 2007-2009 include both AP CS A and AP CS A/B test-takers. In 2010 only AP CS A was offered. Data provided by College Board[xxxv]

Table 6: Demographics in Exploring Computer Science, 2010-11
(Los Angeles Unified School District)

Ethnicity	Female	Male	Total
Latino/a	389 / 18.2%	582 / 42.3%	**971 / 70.5%**
Asian	72 / 5.2%	104 / 7.6%	**176 / 12.8%**
African American	66 / 4.8%	67 / 4.9%	**133 / 9.7%**
White	32 / 2.3%	52 / 3.8%	**84 / 6.1%**
Pacific Islander	2 / 0.15%	4 / 0.29%	**6 / 0.44%**
Unknown	2 / 0.15%	3 / 0.22%	**5 / 0.36%**
Filipino	1 / 0.07%	1 / 0.07%	**2 / 0.15%**
TOTAL	**564 / 41.0%**	**813 / 59.0%**	**1,377**

Table 7: Demographics in Exploring Computer Science, 2011-12
(Los Angeles Unified School District)

Ethnicity	Female	Male	Total
Latino/a	734 / 34.4%	915 / 42.8%	**1649 / 77.2%**
African American	92 / 4.3%	108 / 5.1%	**200 / 9.4%**
Asian	46 / 2.2%	81 / 3.8%	**127 / 5.9%**
White	25 / 1.2%	57 / 2.7%	**82 / 3.8%**
Filipino	21 / 0.98%	47 / 2.2%	**68 / 3.2%**
Native American	4 / 0.19%	5 / 0.23%	**9 / 0.42%**
Pacific Islander	1 / 0.05%	0 / 0.0%	**1 / 0.05%**
TOTAL	**923 / 43.2%**	**1,213 / 56.8%**	**2,136**

Table 8: Enrollment in Exploring Computer Science Across California

DISTRICT	2008-09	2009-10	2010-11	2011-12
Los Angeles USD	306	921	1,377	2136
Healdsburg USD	0	0	20	23
Oakland USD	0	0	86	97
San Jose Area Schools:				
East Side Union HSD	0	0	121	190
Santa Clara USD	0	0	0	41
San Jose USD	0	0	24	63
TOTAL	**306**	**921**	**1,628**	**2,550**

Note: In spite of the severe budget cuts facing the Los Angeles Unified School District (LAUSD), ECS will be expanding to ten more schools during the next school year and will possibly have over 2,000 students taking it in LAUSD alone with the vast majority of students coming from underrepresented populations.

Appendix B. Pros and Cons of Different a–g Classifications for CS

CS as a "g"

Pros	Cons
• Exists already with numerous courses • Larger teacher pool to draw from • Linked Learning and CTE connections • Perkins funding • Not tested, so more flexibility in offerings and content taught	• Elective status – not core • Many non CS classes can fulfill g requirement • Electives tend to get dropped in times of budget crisis • Teachers do not need to be highly qualified to teach CS courses

CS as a "c"

Pros	Cons
• CS would be brought into the core with more attention, resources and emphasis • UC has approved C computing courses and is open to adding more	• Most CS classes do not have enough pure math to apply • CS teachers would need a math certification – big impact on small schools and teacher pool

CS as a "d"

Pros	Cons
• CS would be brought into the core with more attention, resources and emphasis • Would enable the creation of CS specific standards separate from CTE • 4 years of science are recommended so there might be room for CS to be an alternative to a course like Physics	• CSET exam would need to be created and teachers would need to pass it in order to teach CS courses • CS is not considered as one of the "foundational sciences" and would not qualify under current UCOP standards • CS courses would largely be geared to advanced levels of students with higher levels of competency in math (Algebra 2 and up)

CS as an "h"

Pros	Cons
• H classification could allow for a focus on CS and Engineering as a standalone entity – increasing status • Would increase access of opportunity for students	• H classification does not exist – would need to be created. • Would have budget implications which is highly problematic • UC staffer indicated resistance to creation of new categories • Many students already struggle to meet existing "a-g" requirements. • Credentialing uncertain

Appendix C. Industry Sector: Information Technology - Computer Science

Pathway: Programming and Systems Development Pathway **Created by Alyssa Lynch**

DRAFT

California Sample Program of Study

Level	Grade	English Language Arts	Math	Social Studies	Science	Career Technical Education Course	Other Required Courses or Recommended Electives		Sample Occupations relating to t pathway (Including SOC Code)
MIDDLE SCHOOL	7	Reading Language Arts	Pre-Algebra	World History /Geography	Life Sciences	Computer Basics			**Occupations requiring a high scho diploma** ➢ **Administrative Support** ➢ **Data Entry Clerk** ➢ **Software Applications Support** **Occupations requiring some post-secondary** ➢ **Computer Technician** ➢ **Network Specialist** **Occupations requiring a 2 year Degree** ➢ **Computer Programmer** ➢ **Web Designer** **Occupations requiring a BA/BS Degree** ➢ **Game Programmer** ➢ **Software Engineer** ➢ **Computer Scientist**
	8	Reading Language Arts	Algebra 1	US History /Geography	Life Sciences	Web Design			
SECONDARY	9	English 1	Geometry	Geography	Integrated Science	Digital Tools			
	10	English 2	Algebra 2	World History	Biology	Exploring Computer Science (ECS)			
	11	English 3	Intermediate Algebra 2 / Trigonometry	US History	Chemistry	Computer Science Principles (CSP)			
	12	English 4	Trigonometry/Pre-Calculus	American Gov't.	Physics	AP Computer Science			
POSTSECONDARY	**Articulated dual credit courses must be taken/moved to the secondary level for articulation/dual credit purposes.**								**Industry recognized certifications licenses, credentials or apprenticeships related to this pathway.** ➢ Microsoft Certified Compu Expert ➢ Sun Java Developer
	13	**A. Language and Rationality:** A minimum of six (6) semester units. A minimum of three (3) semester units is required in English 1A and a minimum of three (3) semester units in communication and analytical thinking courses **B. Natural Sciences:** A minimum of three (3) semester units to include inquiry into the physical universe and its life forms.	Major Requirements: CIS 4A Computer Programming1 4 CIS 4A1 Computer Programming (Java) 4 CIS 04-B1 Computer Programming II 4 CIS 45A Introduction to Unix 3 CIS 97.1A Computing Studies Practicum 3 Math 3A-B Analytical Geometry and Calculus 5 Math 19 Discrete Mathematics 4 Phys 4A Engineering Physics-Mechanics Phys 4B Engineering Physics-Electricity Plus 3 Additional Major Electives 9			CIS 4A1 Computer Programming (Java)			
	14	**C. Humanities:** A minimum of three (3) semester units which cultivate the intellect, imagination, sensibility and sensitivity **D. Social Science:** Series 1: Social and Behavioral Sciences **E. Lifelong Understanding and Development** Three (3) units from Area A, B, C or D, which are not part of the student's major.							
		F. Cultural Diversity: A minimum of three (3) semester units to prepare students to work effectively and live harmoniously in a pluralistic society, **G. Physical Education Activity:** A one (1) semester unit activity course in physical education (P.E. 1.02 -11.10) is required to receive an Associate Degree							

Junior High/Middle School:	Moreland Middle School
High School:	Westmont High School
Community College:	West Valley College
College/University:	SCU/SJSU

Required Courses

Career Technical Education Courses

Other Required Courses and Recommended Electives

Dual/Concurrent Enrollment – Articulated Courses

Appendix D. Texas Computer Science Education[xxxvi]

Texas Computer Science Courses

There are a number of high school courses classified as Computer Science in Texas. The courses and standards have been under revisions for the past year. The courses under the new (beginning school year 2012 - 2013) curriculum standards are:

1. Fundamentals of Computer Science (One-Half to One Credit),
2. Computer Science I (One-Half to One Credit),
3. Computer Science II (One Credit),
4. Computer Science III (One Credit),
5. Digital Forensics (One-Half to One Credit),
6. Discrete Mathematics (One-Half to One Credit),
7. Game Programming and Design (One-Half to One Credit),
8. Mobile Application Development (One-Half to One Credit),
9. Robotics Programming and Design (One-Half to One Credit),
10. Independent Study in Technology Applications (One-Half to One Credit)
11. Independent Study in Evolving/Emerging Technologies (One-Half to One Credit)

Fundamentals of CS (similar to CS:Principles), CS I (AP CS A), and CS II are taught most often.[xxxvii]

Texas Teacher Certifications

Teacher certifications exist for Computer Science as well as for Technology Applications. There is an old certification called Computer Information Systems. Teachers may still hold the CIS certification (grand fathered), but it is not granted any more. Instead it was replaced eight or nine years ago by a Computer Science 8-12 certification.[xxxviii]

Texas CS Enrollments, 2010 – 2011

In 2010-11, there were 250 teacher FTEs for high school computer science throughout Texas. In the same year, there were approximately 23,000 high students enrolled in computer science courses (does not include information technology courses), out of 1.35 million students. FTEs and course enrollment are available on-line.[xxxix]

Strong Texas High School Programs

Based on attendance at UT Austin's CS4HS workshops and participation in UTAustin's CS contest as well as the state CS contest, there are approximately 100 strong CS programs across the state out of 1500 high schools. It is estimated that roughly one half of the schools teach some form of CS.

Some examples of strong programs (as defined by a teacher who only does CS, possibly more than one CS teacher at the school, and/or two or more different CS classes taught.)

A. Seven Lakes High School, Paul Stroud, PaulMStroud@katyisd.org
B. Port Aransas High School, Laurie Barello, barello@paisd.net
C. Westwood High School, Jeff C. Mickel, jeff@mickel.net
D. Friendswood High School, Annette Walter, agwalter@sbcglobal.net
E. Rockport Fulton High School, John Owen, jowen@acisd.org
F. James E Taylor High School, Don Adams, DonaldRAdams@katyisd.org

G. Needville High School, Delta McFarland, mcfarlandd@needvilleisd.com
H. Cinco Ranch High School, Sean Campbell, SeanFCampbell@katyisd.org
I. Cypress Woods High School, Stacey Armstrong, Stacey.Armstrong@cfisd.net
J. Dallas TAG, Glen martin, gmart039@dallasisd.org

Texas Extracurricular Programs

In Texas, there is also a statewide organization that runs academic high school contests, the University Interscholastic League. It started with speech and debate and expanded to other academic subjects. There is a computer science contest with a written exam and an ACM style programming contest. Schools hold open contests throughout the year and there is a statewide competition as well with several levels of advancement (district to regional, regional to state). This presence of an official extra curricular contest helps promote CS at the high school level. [xl]

Appendix E. Israeli Computer Science Education[xli]

Israeli Computer Science Curriculum

In Israel, computer science has existed as an autonomous subject in the high school curriculum since the mid-1970s; although it is not required, it is an elective on par with physics, chemistry and biology.

Originally, the curriculum focused on programming and included elective Information Technologies modules such as electronic spreadsheets. Since 1991, however, a new curriculum that places significantly more emphasis on principles and theoretical aspects has been gradually implemented in Israeli high schools. The new curriculum "emphasizes the foundations of algorithmic thinking, and teaches programming as a way to get the computer to carry out an algorithm".[xlii] The program is modular and comes in two versions—basic and advanced. It includes mandatory Fundamentals and Software Design modules as well as elective modules, including Second Paradigm, Theory, and Applications.

The success of the high school computer science curriculum in Israel is largely due to the care with which the government planned the implementation process and the resources that were put in place to support that implementation. This support included the development of course materials (learning materials for students and corresponding teacher guides) and an intensive in-service teacher training program.[xliii]

Computer Science Courses

In Israel, secondary school students take one of two computer science programs: one program consisting of three 90-hour units and another consisting of five 90-hour units. The three-unit program includes two core courses (Fundamentals 1: Foundations in Computer Science and Fundamentals II) and a third unit in which students can choose from a selection of courses (Logic Programming, Computer Organization and Assembly Language, Information Systems, and Graphics). The five-unit program includes all of the same courses as the three-unit program, but includes two additional units: one on Software Design and one on Theory. In the Theory unit, students can choose either a Computational Models course or a Numerical Analysis course. These subjects are all covered either in undergraduate courses or in teacher preparation programs.

Israeli Teacher Certification[xliv]

In Israel, computer science teachers are required to meet a rigorous set of criteria, which includes a formal undergraduate computer science degree and graduation from a teacher preparation program. University Computer Science departments provide courses for students seeking a computer science degree as well as for teachers preparing to teach computer science in schools. Teacher preparation programs are offered either by Computer Science departments or by Education departments or schools, or by Science Teaching departments.

Endorsement or Certificate Requirements

In Israel, all teachers must be certified by the Ministry of Education, which oversees education policy and implementation for the entire country. This certificate is achieved upon the successful completion of an undergraduate degree study program and a teacher preparation program.

Alternative Teacher Requirements

The Israeli teacher certification requirements provide no alternative to full certification for teachers currently entering the field. However, when these teacher certification requirements were mandated in the mid 1990s, the government supported an extensive mandatory in-service program to provide professional development (delivered by academic institutions) for those who were already teaching.

Professional Pathway

Israel does not provide an alternative pathway to teaching computing. All teachers must meet the same pre-service and in-service requirements.

Pre-service Requirements

The computer science teacher preparation program has three components:
1. Academic credits in Computer Science, at the Open University of Israel (OUI). These credits include the following courses:

- Algorithmics: The Foundations of Computer Science, which provides a bird's-eye-view of the discipline, and the seminar,
- Topics in Computer Science Education.

Students who have taken these courses as part of their bachelor's degree studies are also required to take other courses in computer science.
2. Academic courses in Education, including (at the OUI):

- Critical Thinking: Statistical and Intuitive Considerations,
- Curriculum Design, Development, and Implementation, and
- either Educational Psychology or Individualized Instruction.

3. Methodology and field experience. Every student must take the Methodology of Computer Science Teaching course or workshop, and successfully complete the field experience during which they have to observe a number of classroom lessons and practice teaching about five lessons in a designated school.

In-service and Professional Development Requirements

Today, the Ministry of Education supports in-service training as the curriculum is updated and new learning units are added. Thus training is mandatory for all computer science teachers. Israel has no on-going professional development requirements for teachers beyond mandatory in-service for updated or new curriculum content.

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