Rebooting the Pathway to Success

Preparing Students for Computing Workforce Needs in the United States

Association for Computing Machinery

Rebooting the Pathway to Success

Preparing Students for Computing Workforce Needs in the United States

Education Policy Committee
Association for Computing Machinery

Lisa Kaczmarczyk
Researcher and Writer, Member of the ACM Education Council

Renee Dopplick
ACM Public Policy Office

Association for Computing Machinery

http://pathways.acm.org

Association for Computing Machinery
2 Penn Plaza, Suite 701
New York, NY 10121-0701

Rebooting the Pathway to Success: Preparing Students for Computing Workforce Needs in the United States
ACM ISBN: #978-1-4503-2828-9
ACM Order Number: #599143

Request permission to republish from:
ACM Publications Department
Fax: +1-212-869-0481
permissions@acm.org

Additional copies may be ordered from:
ACM Order Department
P.O. Box 30777
Church Street Station
New York, NY 10087-0777
+1-800-342-6626 (U.S.A. and Canada)
+1-212-626-0500 (All other countries)
Fax: +1-212-944-1318
acmhelp@acm.org

ACM Education Policy Committee

Robert B. Schnabel (Chair)
Indiana University

Stacey Armstrong
Cypress Woods High School

Robert D. Campbell
CUNY Graduate Center

Fred Chang
University of Texas

Joanna Goode
University of Oregon

J Strother Moore
University of Texas

Susan Rodger
Duke University

Mark Stehlik
Carnegie Mellon University

Chris Stephenson
Computer Science Teachers Association

Eugene H. Spafford (ex officio)
Purdue University

John White (ex officio)
ACM Executive Director and CEO

http://acm.org/public-policy/education-policy-committee

Table of Contents

Foreword

This report, *Rebooting the Pathway to Success: Preparing Students for Computing Workforce Needs in the United States*, represents the next significant step in the Association for Computing Machinery's (ACM) commitment to see rigorous computer science education play a core role in secondary education. This commitment stems from ACM's landmark report on offshoring and outsourcing (*Globalization and Offshoring of Software*, www.acm.org/globalizationreport), and its finding that to be competitive and successful in the 21st century, a country's workforce needs a solid education in the fundamentals of computer science and mathematics.

In the United States, ACM's commitment to rigorous K–12 computer science education has involved a wide range of activities. These include: supporting the development of curricular standards at all levels; participating in the creation of a new secondary-level computer science course and new approaches to teaching it; developing new approaches to training and certifying secondary computer science teachers; creating a national community of secondary-level computer science teachers; educating policymakers on the importance of computer science; and convincing states, school districts, and individual schools to bring computer science into their curricula as a core subject.

Collectively, the above activities are aimed at shifting the U.S. education system—a monumental task. At every step of this effort, it is necessary to convince individuals in positions of influence that the need for a solid education in computer science is a national imperative. The reasons are compelling: (1) the majority of new jobs in STEM-based careers will be in computing fields or will require a deep understanding of computer science; (2) access to rigorous computer science education is an important individual right since it provides students with the problem solving and analysis skills that are invaluable to many career disciplines; (3) computer science education serves as the entry for pathways to successful, rewarding, and fulfilling computing careers; and (4) the country's future innovations and economic prosperity depend strongly on its excellence in computer science.

A crucial step in examining U.S. secondary education in computer science was the report *Running on Empty: The Failure to Teach K–12 Computer Science in the Digital Age*, www.acm.org/runningonempty, released in 2010. Its data showed clearly that computer science curricular standards were not widely adopted, and that rigorous computer science courses rarely counted as a core mathematics or science high school graduation requirement.

This report is a successor to *Running on Empty*, examining the workforce demand for computing professionals and discussing successful computer science education pathways. It contains a nationwide assessment of the computing workforce landscape and the extent to which states are preparing students with fundamental computer science knowledge and skills. It demonstrates that there is a substantial computing workforce in every state, and it shows that the size of this workforce will grow significantly over the next decade. The report also demonstrates that few states are positioned to provide the computer science education required for rewarding careers and for ensuring future workforce needs are met. Finally, it shows through examples that a diverse set of states and municipalities have developed and implemented programs for teaching computer science in both academic and career technical education tracks. These programs can serve as models for policymakers and educators to consider when developing plans to expand computer science education in their own contexts.

The findings of this report are clear, and they are relevant to every country. Education in the fundamentals of computer science is key to individuals in a country having access to rewarding careers, and it is key to a country developing and sustaining a competitive 21st century workforce and succeeding in innovation.

Robert B. Schnabel
Chair, ACM Education Policy Committee

Vint Cerf
ACM President

John White
ACM Executive Director and Chief Executive Officer

Executive Summary and Recommendations

- Nationwide Call to Action
- Recommendations
  - For All Levels Of Government
  - For State Departments of Education, Labor, and Employment
  - For Education Policymakers and Educators
  - For Business Leaders

Executive Summary and Recommendations

Computing jobs are among the fastest growing areas of employment in the United States. By 2020, one of every two jobs in the "STEM" fields (science, technology, engineering, and mathematics) will be in computing. These occupations pay extremely well, providing opportunities for U.S. workers to embark on dynamic careers, enjoy a good standard of living, and contribute to the innovation that drives the country's economic growth.

High-skilled, high-wage computing jobs are found in all regions of the country and in every significant industry sector. Industry leaders from inside and outside traditional technology companies widely recognize the growing demand for computing workers in many sectors. Nearly all of these jobs require a postsecondary degree. Immediate action is needed to increase the pipeline of qualified students obtaining computer science and other computing-related degrees, and to prepare them for the 21st century workforce.

To that end, state policymakers, educators, and workforce leaders should work together to create computer science education pathways essential to expanding students' career opportunities in computing-dependent occupations. These education pathways should expose all students to computer science and provide expanded access to more rigorous computer science courses.

To create effective pathways, each state should develop and implement computer science education and computing workforce plans that spread through all levels of the education system. These plans should foster increased opportunities for students in academic and career technical education programs to gain the computer science knowledge and skills needed to compete for high-wage employment. Key elements for achieving increased opportunities include: (1) the availability of and graduation credit for rigorous computer science courses in high school, (2) certified computer science teachers, (3) recognition of computer science courses in college admissions policies, (4) articulation agreements to allow for the efficient transfer of computer science courses across postsecondary institutions, and (5) actions to facilitate the full participation of women, minorities, and students with disabilities in computer science education and career pathways.

Unfortunately, current state standards and proposed STEM education reforms largely omit computer science from the core subjects that K–12 students are expected to learn. Only 17 states and the District of Columbia clearly allow an Advanced Placement (AP) computer science course to satisfy a core high school graduation requirement in mathematics or science. To promote academic quality, states or localities should adopt a clear definition of rigorous computer science that is grounded in the *CSTA K–12 Computer Science Standards* developed by the Computer Science Teachers Association (CSTA). Further, a rigorous computer science course should be recognized as a means for satisfying a core high school graduation requirement in computer science, mathematics, or science.

Expanding access to computer science for K–12 students is only one aspect of addressing current needs. Students can take computer science courses only if well qualified teachers are available to teach them. Yet, the process of qualifying to teach computer science can be difficult to discover and difficult to achieve. To ensure that teachers achieve excellence in their daily work, states or localities should establish clear, relevant, and attainable requirements for computer science teacher certification.

Two-year and four-year postsecondary institutions represent critical components of these education pathways. By recognizing computer science courses in admissions, they can create incentives for high school students to acquire the academic background needed for postsecondary pathways that can lead to high-wage computing careers. Higher education institutions also can reduce barriers to degree completion by adopting comprehensive, system-wide articulation agreements to help students who move from two-year to four-year institutions complete their computer science and other computing-related degrees efficiently and effectively.

Underpinning all of these efforts is the need for computer science education pathways that promote a diverse and inclusive computing workforce. Developing a broad-based pool of computing talent reflective of the country's demographics is crucial to expanding technological innovation vital to the country's growth and the success of U.S. businesses. Economic realities dictate that the United States needs to greatly increase the share of women, Hispanics/Latinos, Blacks/African Americans, and other currently underrepresented groups in the computing workforce.

Satisfying the growing national demand for a skilled computing workforce poses significant challenges. Several exemplary computer science education initiatives across the country serve as potential models to overcome these challenges. Representative examples of these initiatives, as described in this report, offer inspiration to increase access to computer science education, address issues of diversity, and provide all students with the foundational computer science knowledge and skills important to success in virtually every career.

Nationwide Call to Action

Industry leaders, state education leaders, and policymakers should join forces in preparing students for the growing computing workforce that drives innovation and sustains economic growth. Working together, they should design and implement comprehensive computer science education and computing workforce development plans that increase opportunities for academic and career technical education programs. These plans should align state policies, programs, and resources to foster computer science education requirements that enable K–12 students to succeed in postsecondary degree programs in computer science and other computing-related fields. In support of that goal, we offer ten recommendations in this report.

Recommendations

Overall Recommendation: Each state needs to have an education and computing workforce development plan that includes K–12 computer science education, and should align state policy, programs, and resources to support the plan.

Detailed Recommendations

1. Each state's plan should have strategies to fill its computing workforce needs in the growing number of computing-dependent occupations both inside and outside traditional high-technology industries.
2. All students should have access to, and be encouraged to complete, a rigorous computer science course in high school.
3. Rigorous computer science courses should count as a core high school graduation requirement in computer science, mathematics, or science.
4. States or localities should adopt a clear definition of rigorous computer science grounded in the *CSTA K–12 Computer Science Standards* and should establish clear, relevant, and attainable requirements for computer science teacher certification.
5. States and major school districts should adopt education paths for computer science within both academic and career technical education programs.
6. College and university admissions requirements should allow incoming students to count a rigorous computer science course as a core credit.
7. Community colleges, four-year colleges, and universities should create clear articulation agreements for the transfer of computer science courses.
8. Each state's computer science education and computing workforce development plan should include explicit actions for obtaining the full participation of females and other underrepresented populations.
9. State and local STEM councils should include computer science representation.
10. Business and government leaders should clearly articulate the importance of the computing field to the economy and to community wellbeing.

Introduction and Organization of this Report

- About this Report
- Organization of this Report

What does the occupational landscape across the United States look like for current and future computing workers?

Given the nationwide demand for computing workers and the push for states to expand and improve STEM education, to what extent are states providing access to and support for K–12 computer science education?

About this Report

This report presents results of a study conducted by the Association for Computing Machinery (ACM) Education Policy Committee in 2013 to assess the U.S. computing workforce landscape and its correlation to the extent to which states are preparing K–12 students with the fundamental computer science knowledge and skills needed to enter the computing workforce or pursue a postsecondary computer science or other computing-related degree.

ACM undertook this study to answer two basic questions related to the state of computer science education and computing workforce development in the United States.

1. ***What does the occupational landscape across the United States look like for current and future computing workers?***
2. ***Given the nationwide demand for computing workers and the push for states to expand and improve STEM education, to what extent are states providing access to and support for K–12 computer science education?***

This study gathered data from all 50 states and the District of Columbia on the presence of computing jobs and what salaries those computing jobs are paying. The study also examined the extent to which students are taking the Advanced Placement (AP) Computer Science A exam in high school, and then to what extent states are awarding postsecondary computer science and other computing-related degrees. These metrics paint a picture of how well states are preparing students for computing careers.

Organization of this Report

Executive Summary and Recommendations provides an overview of the results of the study and the major implications for education and workforce development. It also identifies ten specific recommendations for policymakers, administrators, educators, and business leaders.

U.S. Computing Workforce Context presents the spectrum of computing jobs and sectors that exists today and is projected into the future. It reports on the growing numbers of traditional computing jobs, as well as the accelerating presence of interdisciplinary computing jobs. It discusses the workforce need for students with computer science and other computing-related degrees and for students with a deep knowledge of computer science as part of other degrees.

Education Pathways to Computing Jobs discusses the need for increased opportunities in K–12 STEM education for obtaining the necessary foundations in computer science. It explores the impact of K–12 computer science education on postsecondary opportunities to pursue computer science and other computing-related degrees and to obtain high-wage computing employment. It examines the demographic imbalance that exists at all levels of computer science education.

Computer Science Education Initiatives highlights a diverse sample of computer science education initiatives currently underway across the country. It presents an overview of each project's approach to increasing access to computer science in K–12, and for simultaneously addressing issues of diversity. This section provides potential models that can serve as inspiration for policymakers to consider when developing computer science education and computing workforce plans in their own contexts.

Appendix – State-by-State Reports provides a state-by-state breakdown of computing jobs and salary data, postsecondary computer science and other computing-related degrees awarded, and high school students taking the Advanced Placement (AP) Computer Science A exam. It presents a state-level report detailing the challenges and opportunities for computer science education and thus for meeting future technology workforce needs.

U.S. Computing Workforce Context

- Where Are the STEM Jobs?
- Understanding the Demand for a Computing Workforce

1 of every 2 STEM jobs will be a computing job.

High-wage computing jobs are providing most of the newly created STEM jobs.

The global trend toward development of knowledge-intensive economies is placing pressure on the United States to increase support for technological innovation through the commercialization of research and development, and the STEM jobs that enable this activity. Yet even with today's ubiquitous presence of digital technology, there is a breakdown in the pipeline of STEM workers with the knowledge and skills needed to envision, develop, and market the next generation of technological advances vital to the country's economic growth and the success of U.S. businesses.

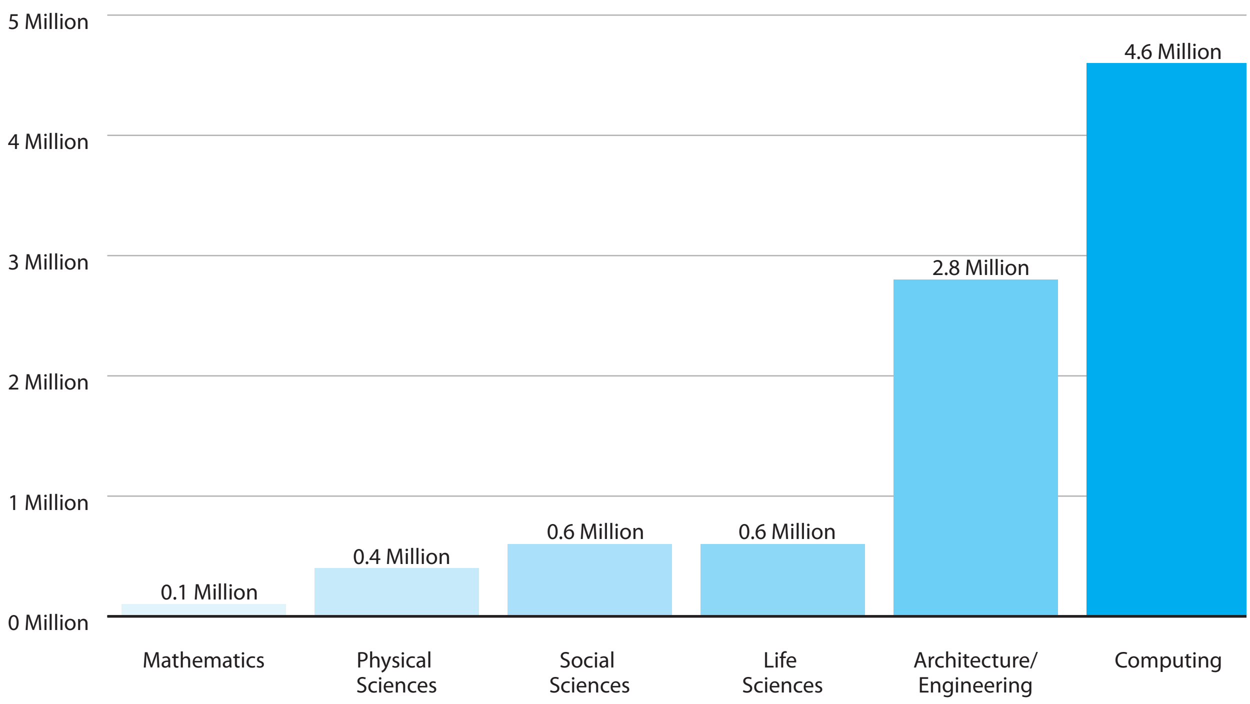
Technology sector jobs, particularly computing jobs, are rapidly increasing across the United States. Computing jobs are found both inside and outside traditional high-technology companies, in every region of the country, contributing to innovation and entrepreneurship in virtually every industry. For example, business intelligence is an expanding career field where computing professionals contribute directly to enhancing the competitive advantage of their organizations. In addition, embedded systems developers are being hired in primarily rural, as well as densely populated, states to develop the software that drives an ever-growing number of wifi-enabled sensor devices. As consumers continue to demand access to information, data, and services wherever they are, computing jobs such as these will continue increasing.

As a result of the increasing presence of technology, computing employment is outpacing all other types of STEM jobs, including those in the life sciences and engineering. In fact, the U.S. Bureau of Labor Statistics (BLS) projects that, by the end of the decade, 4.6 million of the 9.2 million STEM jobs will be computing jobs. In other words, by 2020, one of every two STEM jobs will be a computing job.

Computing jobs are providing most of the newly created STEM jobs as well. The BLS estimates 62% of the new STEM jobs created through 2020 will be computing jobs. Engineering places a distant second at 20%.

Fueling the demand for computing workers is the interdisciplinary nature of many computing occupations. In addition to the high need for computing specialists in every significant industry sector, diverse categories of workers in a growing number of traditional industries are required to

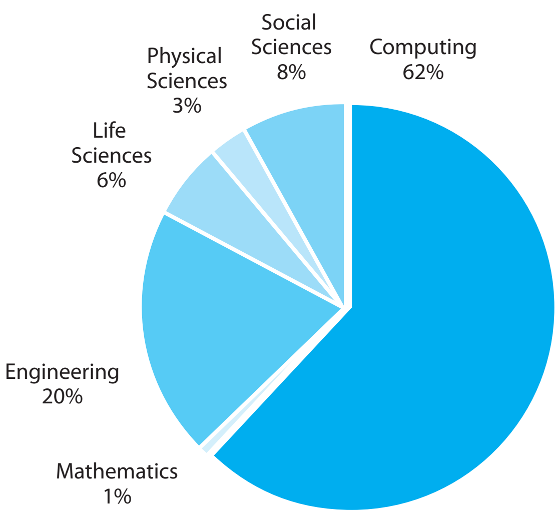
FIGURE 1 **Total Employment in STEM in 2020**



have foundational computer science knowledge and skills. Such industries include architecture and engineering, business and finance, education, environment, healthcare, law, media, and public services. Computer science expertise permits geologic and atmospheric modeling and enables advances in digital imaging and data management. The Congressional Budget Office predicts that, as a result of the federal HITECH Act of 2009, 90% of physicians in the United States will use electronic health records by 2019. This need for computer science expertise across all industry and public sectors is making computer scientists with a dual background in another field especially appealing to many employers.

Computing occupations also pay extremely well. The average computing salary exceeds the average salary in all 50 states. In 2012, the BLS reported the national average salary for computing occupations was $80,020/year. Top paying positions, such as Computer and Information Research Scientists, averaged $103,670/year, with Systems Software Developers not far behind at $102,550/year. Even

FIGURE 2 **Projected Newly Created STEM Jobs 2010–2020**



Source: U.S. Bureau of Labor Statistics. Employment Projections 2010–2020.

Business and government leaders should clearly articulate the importance of the computing field to the economy and to community wellbeing.

the "lower" paying computing occupations typically average salaries in excess of $75,000/year.

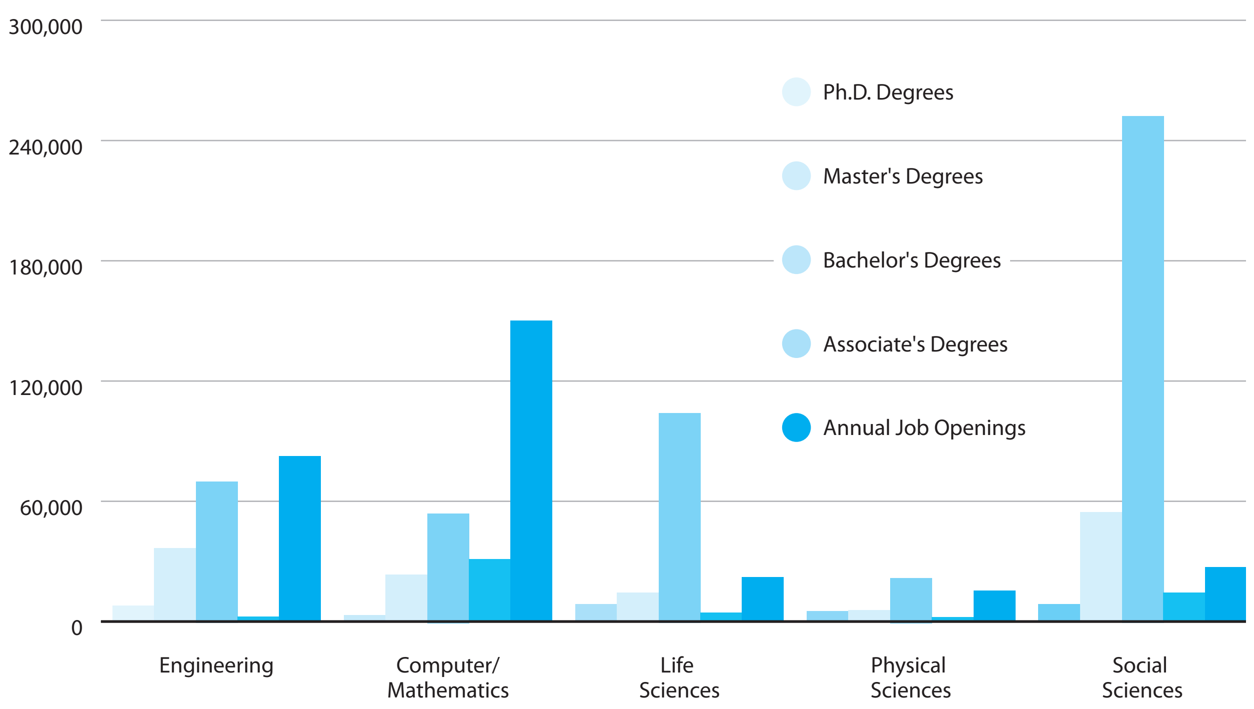
Diversity figures in the current computing workforce are low. According to the BLS, only a quarter (25.6%) of the workers in computer and mathematical occupations in 2012 were women. Only 7.4% were Blacks/African Americans, who comprise 13% of the U.S. population, and only 6.1% were Hispanics/Latinos, who comprise 17% of the U.S. population.

Building a diverse computing workforce has business, economic, and social benefits. Diverse perspectives are critical for developing innovative products and services, as well as for identifying ways to use technology to enhance the performance and productivity of U.S. businesses. Equally important are the significant equity issues the United States will face as a country if women, minorities, and people with disabilities are left behind as computer science becomes increasingly relevant to a range of high-paying occupations.

The BLS estimates there will be roughly 150,000 annual computing job openings between now and 2020. A postsecondary computer science or other computing-related degree not only opens the door to most of these computing jobs, but also, in many cases, it is required. As the number of STEM jobs concentrated in computing is projected to continue growing, it is important for the number of graduates to keep pace with the high need for qualified computing workers.

If states are to take full advantage of the growth in the computing field, they must begin to address these workforce needs immediately, beginning with comprehensive computer science education and computing workforce plans. Each state should create a pipeline of interested students who are educationally prepared to complete postsecondary computer science and other computing-related degrees. All students should have access to K–12 computer science and should be encouraged to take computer science. Creating a state's computer science education and workforce development plan requires the active participation of policymakers, education leaders, and industry leaders in that state. In the Computer Science Education Initiatives section of this report, we highlight several nationally recognized programs that are integrat-

FIGURE 3 Where the STEM Jobs Will Be: Degrees vs. Job Openings Annually



Source: Degree data obtained from the National Science Foundation, *Science and Engineering Indicators 2012*. Annual jobs data calculated from the U.S. Bureau of Labor Statistics, Employment Projections 2010–2020.

ing computer science education into schools.

State and local STEM councils also can play an important role in defining the computer science knowledge and skills critical for all students. Too often, though, STEM councils restrict the definition of "STEM" to include only core mathematics (e.g. algebra, geometry) and core science (e.g. physics, chemistry, biology, etc.), while computer science is overlooked. These councils should specifically include computer science as part of any STEM initiative and should provide computer science representation from both industry and education.

Technological innovation and an education system that prepares students for the rapidly growing number of domestic computing jobs are key components of the ability of U.S. businesses to compete in the global economic marketplace. High-skilled, high-wage computing jobs are available in every region of the country and are located in both high-technology companies and the majority of traditional industries. These jobs are integral to the competitive positioning of many U.S. businesses, playing a central role in their ability to innovate and develop cutting-edge products and services.

Comprehensive computer science education and computing workforce development plans are needed to create effective pathways to prepare interested students for entry into computing-dependent occupations. These pathways should begin by providing all students with access to rigorous K–12 computer science.

Education Pathways to Computing Careers

- Why Teach Computer Science in K–12 Education?
- Understanding Computer Science Education
- Creating Education Pathways to Computing Careers

States and major school districts should adopt education paths for computer science within academic and career technical education programs.

For over a decade, discussions about education reform at all levels of government have focused intensely on STEM education. Major curricular initiatives, including the Common Core State Standards and the Next Generation Science Standards, are being adopted across the country, requiring students to become more proficient in mathematics and science. States and districts are placing stricter requirements on schools to assess the readiness of students for postsecondary STEM degree programs. At the same time, industry leaders are calling loudly and clearly for additional high-skilled computing workers.

Students in academic and career technical education (CTE) programs need increased opportunities to acquire the knowledge and skills necessary to pursue postsecondary computer science and other computing-related degrees and to obtain the high-wage employment with which these degrees are associated.

States and major school districts should adopt education paths for computer science within academic and career technical education programs.

In 2010, ACM's report *Running on Empty: The Failure to Teach K–12 Computer Science in the Digital Age* identified the numerous and significant gaps between state secondary education standards and nationally recognized computer science standards. The need to increase K–12 computer science knowledge remains true today because the majority of states have failed to implement a comprehensive policy framework that supports computer science instruction.

States seeking to connect student knowledge more deeply to computer science education opportunities could face challenges when implementing the Common Core State Standards and the Next Generation Science Standards. These standards do not include computer science as a disciplinary core idea. Thus, state and local education leaders will need to take proactive steps to integrate computer science concepts and courses within or as additions to these frameworks. For example, computer science courses can provide students with concrete STEM learning experiences and with the college preparatory background and career-ready skills emphasized by the standards.

Despite widespread agreement that K–12 needs to better prepare students for computing-dependent jobs, no state requires all students to take computer science for high school graduation. Only 17 states and the District of Columbia clearly allow computer science courses to satisfy a core high school graduation requirement in mathematics or science. Although a number of states permit a computer science course to satisfy a general elective credit for graduation, there is no guarantee that the course is actually offered.

To complicate matters further, computer science education content varies greatly because of widespread confusion about what academic computer science is. As long as computer science is misunderstood and denied core graduation credit in mathematics or science, the United States will not see the increases in student enrollment in K–12 computer science courses that the country needs. Why? Students are eminently practical when it comes to figuring out how to graduate from high school and gain admission to college. They select courses with several goals in mind, including: satisfying core graduation requirements, creating a competitive college application portfolio, and investigating a subject recommended by people they trust. When computer science is not awarded core graduation credit, it sends a direct message to students, teachers, counselors, and family that computer science is not valuable. Nothing could be further from the truth.

As widely praised programs nationwide demonstrate, computer science should be made available early, and students should be encouraged to take it. The Computer Science Education Initiatives section of this report provides examples of how to introduce computer science to middle and high school students. From these and numerous other programs, we know that when students are exposed to rigorous computer science, they often discover they like it and are good at it. They want to take more of it. They are more willing to take other advanced mathematics and science courses that support success in a college computer science program.

Not discovering early in their K–12 education that computer science is exciting has long-lasting negative consequences. Students not only miss an opportunity to become technically savvy 21st century citizens but also fail to prepare for postsecondary computer science and other

TABLE 1 Where Does Computer Science Count as a Core High School Graduation Requirement?

	Math	Science
Alabama*	✓	
District of Columbia	✓	
Georgia		✓
Indiana	✓	
Michigan	✓	
Missouri	✓	
New York	✓	✓
North Carolina	✓	
Oklahoma	✓	
Oregon	✓	✓
Rhode Island	✓	✓
Tennessee*	✓	
Texas	✓	
Utah	✓	
Vermont	✓	
Virginia	✓	✓
Washington	✓	✓
Wisconsin*	✓	

Source: Computer Science Teachers Association. *Bugs in the System: Computer Science Teacher Certification in the U.S.* (2013) (as amended). *Added in 2013 after the CSTA report was published.

States should establish clear, relevant, and attainable requirements for computer science teacher certification.

computing-related degrees and for lucrative and fulfilling computing careers.

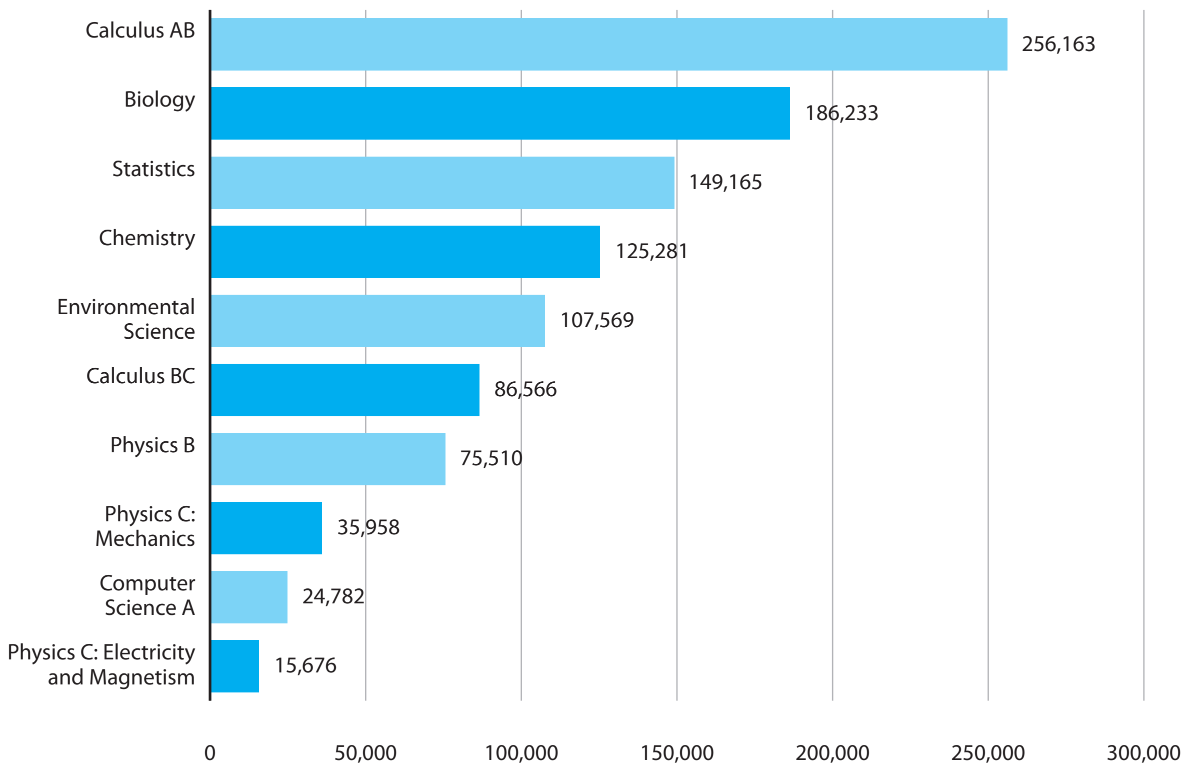
Inspiring students' interest in computer science is only one aspect of addressing current needs as students can take computer science courses only if well-qualified teachers are available to teach them. Ensuring qualified computer science educators in the classrooms requires explicit and relevant computer science teacher certification requirements and pathways. (In this report, we use the term "certification" to refer to all credentials, licenses, and endorsements governing teacher professional practice in each state.) Yet, the process of qualifying to teach computer science can be difficult to discover and difficult to achieve. The Computer Science Teachers Association (CSTA) reported in *Bugs in the System: Computer Science Teacher Certification in the U.S.* (2013) that the state of computer science certification for teachers is rampant with confusion, contradictions, and disincentives. There are literally dozens of certificates, endorsements, and licenses related to computer science education. Because computer science courses can be found in art, business, career technical education, mathematics, and technology education departments, credentialing requirements are extremely diverse. States should establish clear, relevant, and attainable requirements for computer science teacher certification.

Even where computer science teacher certification currently exists, the requirements may be literally impossible to complete. In some documented instances, specific graduate coursework is required even though it is not offered in the state, or industrial experience is required in an area unrelated to computer science.

CSTA reported cases in several states where highly experienced computer science educators were prevented from teaching high school computer science because of arcane and contradictory certification requirements. Statewide computer science teacher certification based on national computer science standards will go a long way towards rectifying this situation.

Exemplary teachers also need to keep their knowledge and skills current, and this requires ongoing professional development. Unfortunately, comprehensive teacher professional development in computer science is rare. Few

FIGURE 4 **Advanced Placement Exams Nationwide in 2012**



Source: College Board. AP Data: National Summary Report (2012).

states have pre-service and in-service teacher education programs to prepare new and existing K–12 teachers to teach computer science. As a result, teachers are required to obtain certification and professional development in subject areas unrelated to computer science. This is a poor use of time and resources when students greatly need qualified computer science teachers to teach rigorous computer science courses. The CSTA report provides an in-depth discussion of the K–12 computer science teacher certification crisis and offers methods to resolve it.

To see the negative ripple effects of sidelining K–12 computer science education, one need only look at national Advanced Placement (AP) exam data. Research by the College Board shows that AP exam choice reflects a student's intent to possibly major in a subject in college. Students who take an AP computer science course are 4.5 times more likely to major in computer science than students who do not.

Yet, in 2012, less than 3% of the more than one million students who took AP exams in STEM subjects took the AP Computer Science A exam (24,782), placing computer science next to last for participation, just above the number of students who took the AP Physics C: Electricity and Magnetism exam.

Contrast these low numbers with the 125,281 students who took the AP Chemistry exam, the 149,165 who took the AP Statistics exam, the 186,233 who took the AP Biology exam, and the 256,163 who took the AP Calculus AB exam. The low participation rate in the AP Computer Science A exam is unacceptable considering that the growth in STEM jobs through 2020 is predicted to be concentrated in computing.

Particular attention should be paid to ensuring successful participation by females and other underrepresented groups in the AP Computer Science A exam. In 2012, less than 20% of AP Computer Science A exams were taken by

Each state's computer science education and computing workforce development plan should include explicit actions for obtaining the full participation of females and other underrepresented populations.

females. Further, across the country, many minority students lack access to upper-level computer science courses, which hurts their chances of taking and passing the AP Computer Science A exam.

This lack of access to rigorous computer science courses further privileges this knowledge, making access not only an academic but also a social justice issue. Fortunately, there are exemplary approaches to computer science teaching and learning such as the program provided by the Los Angeles Unified School District that is described in the Computer Science Education Initiatives section of this report.

Each state's computer science education and computing workforce development plan should include explicit actions for obtaining the full participation of females and other underrepresented populations.

Colleges and universities also have an important role to play by encouraging secondary schools to offer rigorous computer science courses and by encouraging students to take those courses. A highly effective way to get the attention of students, teachers, administrators, and counselors is by counting computer science as a core credit for admission to their institutions.

By recognizing courses such as the AP Computer Science A course and the forthcoming AP Computer Science Principles course, colleges send a clear message to students, teachers, counselors, and family that computer science is highly valued. Conversely, when postsecondary institutions do not award core admissions credit to computer science courses, they send the message that computer science is not important.

The omission of computer science from core high school curricula negatively impacts college and university programs. Although there have been modest increases in the number of postsecondary computer science graduates, the number of jobs available for applicants with a degree continues to grow. Thus, states need to strengthen the pipeline of K–12 students prepared for and interested in pursuing postsecondary computer science and other computing-related degrees.

A closer look at the distribution of computer science degrees reveals a deeper and more troubling trend. Of the bachelor's degrees in computer science awarded

FIGURE 5 **Bachelor's Degrees in Computer Science in 2012 by Gender**

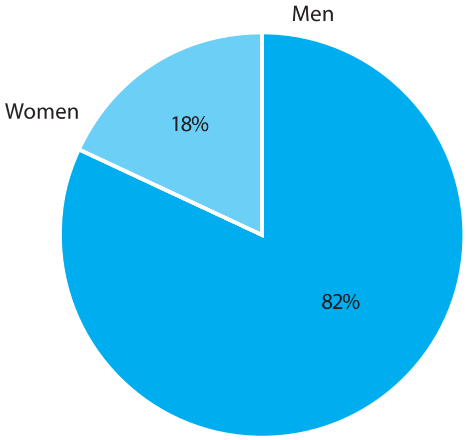
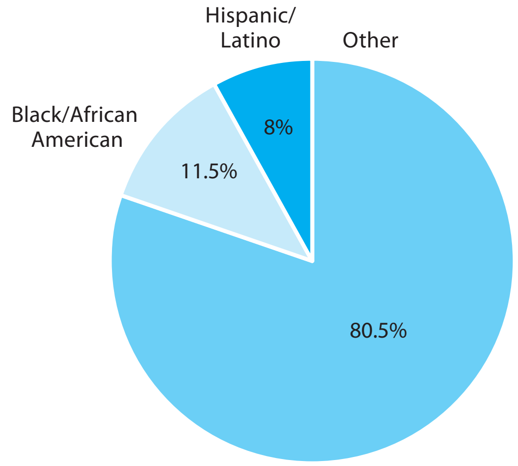


FIGURE 6 **Bachelor's Degrees in Computer Science in 2012 by Hispanics/Latinos and Blacks/African Americans**



Source: U.S. Department of Education, National Center for Education Statistics (2012).

annually in the United States, less than 20% have gone to women since 2007. Statistical data for bachelor's degrees in computer science awarded in 2012 to other underrepresented groups show 11.5% were awarded to Blacks/African Americans, who comprise 13% of the U.S. population, and 8% were awarded to Hispanics/Latinos, who comprise 17% of the U.S. population.

Education leaders and policymakers should not ignore the increasing number of students who begin their post-secondary degrees at two-year colleges. Unfortunately, these students often face significant barriers when they try to transfer computer science courses to another two-year institution or to a four-year institution. Barriers include a lack of communication among institutions and frequently changing or poorly publicized requirements for transferring computer science courses.

Community colleges, four-year colleges, and universities should create clear articulation agreements to enable the efficient transfer of computer science courses.

Very few states have comprehensive, system-wide articulation agreements to help students who transfer from two-year to four-year colleges complete their computer science and other computing-related degrees efficiently and effectively. Every state's computer science education and workforce development plan should include articulation agreements for the transfer of computer science courses across colleges and universities.

Kentucky provides a very good example of how to develop model computer science articulation agreements (see Computer Science Education Initiatives section of this report).

It is clear there are major gaps in the K–12 education policies needed to support quality computer science instruction for all students. Thus, states need comprehensive policy frameworks that include clear and easily accessible computer science education pathways for K–12 students.

At the heart of these plans should be the adoption of clear computer science curricular standards for academic and career technical programs. To engage students in meaningful learning, states should adopt a clear definition of rigorous computer science grounded in the *CSTA K–12 Computer Science Standards* (2011).

Curricular standards and detailed support materials for computer science are readily available. The *CSTA K–12 Computer Science Standards* provide a framework for comprehensive integration of computer science into the primary and secondary curriculum. The standards provide a three-level framework for computer science education, including detailed learning outcomes, sample activities, and other resources to guide implementation.

States should adopt a clear definition of rigorous computer science grounded in the *CSTA K–12 Computer Science Standards*.

The standards are designed to strengthen computer science competency and fluency for all students and to provide clear education pathways for students with an interest in computing careers.

At the high school level, the standards provide examples of how the standards can be met with individual courses.

The first course example, *Computer Science for the Modern World*, is an introductory course which targets all students and provides a hands-on exploration of the interdisciplinary nature of computer science. It includes the use of computational thinking to develop algorithmic solutions to real-world problems and renders activities and concepts more engaging by including critical social and ethical issues that students must confront and address.

The second high school example course in the pathway is *Computer Science Concepts and Practices*. This course is designed to be accessible to all students, deepening their computer science knowledge and skills and better preparing a pipeline of STEM majors. This example course is most closely aligned with the AP Computer Science Principles (AP CSP) course currently being developed by the College Board, in partnership with the National Science Foundation (NSF). The College Board has announced it will launch this new course in 2016 and administer the first exam in 2017. The AP Computer Sci-

TABLE 2 CSTA Computer Science Standards for High Schools

	Audience	Purpose	Course Examples
Level 3A	All students	Introduce the fundamental concepts of computer science so students can use appropriate computational tools and techniques.	Computer Science for the Modern World
Level 3B	All students	Provide more in-depth study of computer science and its relation to other disciplines.	Computer Science Concepts and Practices Advanced Placement Computer Science Principles (AP CSP) [in development by the College Board]
Level 3C	CTE students College-bound students	Allow students to master more advanced computer science concepts and apply those concepts to develop virtual and real-world artifacts.	Advanced Placement (AP) Computer Science A Game programming Industry-certification preparation

Source: Computer Science Teachers Association. *CSTA K–12 Computer Science Standards* (2011).

ence Principles course and exam will appeal to students who are putting together college application portfolios.

The third example course in the standards framework is intended to provide students an opportunity to explore some specific aspect of computer science in more depth. No specific standards are defined for this course. Instead, it is expected that students will choose from a wide variety of optional courses that could include: the AP Computer Science A course, which prepares students to take the AP Computer Science A exam; a project-based course focusing on a single facet of computing, e.g., graphics, game programming, or open-source software; or a course leading to an industry certification.

The examples for high school courses in the *CSTA K–12 Computer Science Standards* exemplify the variety of ways that schools and educators can deliver flexible, differentiated pathways for students.

Creating the Pathways

Each state should align its policies, programs, and resources in support of an education and workforce development plan that includes K–12 computer science education. These plans should create education pathways that provide students easy access to computer science courses, and should put in place policies that encourage students to enroll in those courses.

Policies should include counting a rigorous computer science course as a core high school graduation requirement in computer science, mathematics, or science. Further, states and major school districts should adopt education pathways for computer science within academic and career technical education programs.

Particular attention should be paid to ensuring access to K–12 computer science for women and other groups currently underrepresented in the computing workforce.

Policies also should provide for secondary computer science teacher certification and professional development.

Colleges and universities should encourage all students to take computer science courses in K–12 and support their completion of postsecondary computer science and other computing-related degrees with articulation agreements across two-year and four-year institutions.

Community colleges, four-year colleges, and universities should create clear articulation agreements for the transfer of computer science courses.

Computer Science Education Initiatives

- Making Computer Science Accessible to All Students
- Pathways within Academic Programs
- Pathways within Career Technical Education Programs

This section of the report highlights a diverse sample of successful computer science education initiatives underway across the country to create education pathways for computer science within academic and career technical education (CTE) programs.

These nationally recognized programs serve as exemplars of how the *CSTA K–12 Computer Science Standards*, published by the Computer Science Teachers Association (CSTA), can be interpreted and implemented in ways that teach critical knowledge while deeply engaging students.

The states and districts profiled here are on the forefront of curricular reform and offer proof that we can overcome the challenges facing K–12 computer science education. These projects are increasing access to computer science education and addressing issues of diversity.

These initiatives serve as models from which education leaders and policymakers can draw inspiration when developing computer science education and computing workforce development plans in their own contexts.

Washington

The state of Washington's 10-year strategic education and workforce development plan, titled *High Skills, High Wages* and updated in 2012, prioritizes improving education pathways in response to an economy that is increasingly more knowledge based, technology dependent, and global. The plan highlights computer science as one of the top five "high employer demand" areas needing more qualified workers.

To help strengthen the pipeline of students in advanced computer science courses and postsecondary degree programs, Washington has focused on: (1) increasing the availability of and graduation credit for rigorous computer science courses in high school, (2) adopting flexible education pathways for computer science within academic and career technical education programs, (3) training more computer science teachers, (4) broadening participation by females and other underrepresented groups in the computing field, (5) improving the transferability of computer science course credits across postsecondary institutions, and (6) connecting educators, industry leaders, and policymakers to discuss how to support and expand effective computer science education and computing workforce development plans.

Multiple education pathways allow students in academic and career technical education programs to progress from beginning and exploratory computer science courses to advanced courses that lead to postsecondary degree programs and jobs.

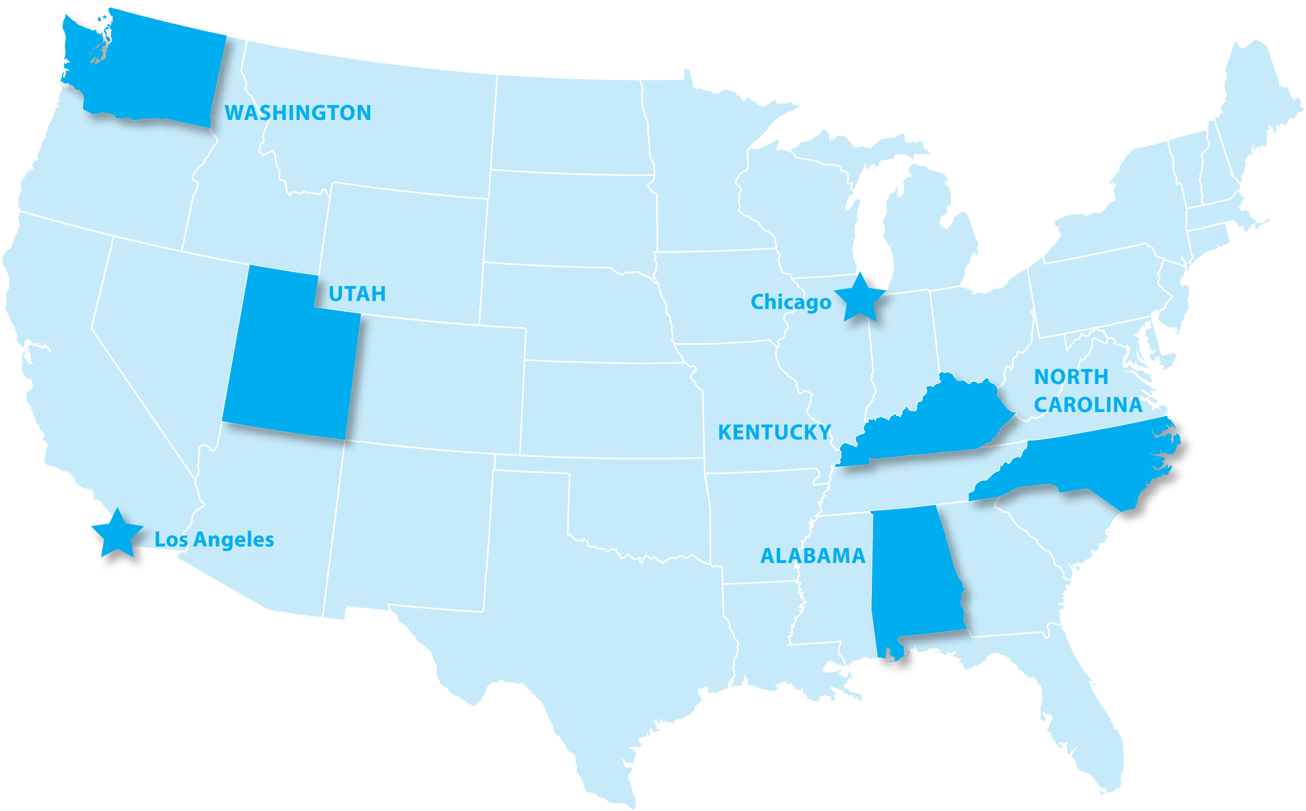
In 2013, Washington became one of a limited number of states to allow students the option of counting a rigorous computer science course as a core high school graduation requirement in either mathematics or science. This new option, approved overwhelmingly by the state legislature, creates the academic incentive for students to take an advanced computer science course. The legislature observed that too few students had been taking AP Computer Science and that granting core academic credit encourages students to view advanced computer science courses as relevant to their future academic or career success.

In addition to allowing college-focused students to count computer science as a core academic credit in mathematics or science, Washington provides students with career technical education "Tech Prep" pathways that allow them to earn tuition-free college credit at community and technical colleges, as well as high school credit. Thus, students in dual credit courses can earn both high school and college credit at the same time. Tech Prep courses also can lead to two-year certificates and apprenticeships in industry.

A public-private initiative with Microsoft, launched in 2011, provides students with an expanded range of computer science courses focused largely on industry-level certifications. The courses span from basic computer skills to advanced courses in software programming and database development. During its first two years, students across the state obtained more than 10,000 certifications.

Consistent with the focus on reaching and supporting diverse populations as outlined in the state's education and workforce development plan, the Washington Mathematics Engineering Science Achievement (MESA) Computer Science Initiative is dedicated to increasing postsecondary computer science education pathways for female, minority, low-income, disabled, and disadvantaged K–12 and community college students. The Initiative, hosted by the University of Washington, offers classes, clubs,

NATIONALLY RECOGNIZED COMPUTER SCIENCE EDUCATION PROGRAMS



after-school programs, summer programs, and mentorship programs with industry professionals.

Articulation agreements for the transfer of credits help students transition from high school into postsecondary programs and from associate's degree programs at community and technical colleges to university bachelor's degree programs. To help decrease barriers across the numerous articulation agreements, the state's education and workforce development plan calls for aligning programs of study along a common frame of reference, such as through common courses and common course numbering. To that end, in 2012, the state-sponsored Center of Excellence for Information and Computing Technology, located at Bellevue College, facilitated collaboration by secondary educators, postsecondary educators, and industry professionals on the development of three common courses: Programming I and II, and Data Structures.

To allow students to complete their associate's degrees after transferring to a bachelor's degree program, the Washington State Board for Community and Technical Colleges offers a "reverse" articulation agreement. The students can transfer relevant university course credits earned at WGU Washington, an online university, back to community and technical colleges to satisfy the requirements for their associate's degrees.

An important element of the state's education and workforce plan is its emphasis on collaboration by educators, industry leaders, and policymakers to address challenges and define solutions for improving and expanding computer science education. The state's Workforce Training and Education Coordinating Board includes representation from a broad range of stakeholders, including the technology industry.

North Carolina

North Carolina provides an example of a state that seeks to increase students' workforce readiness for computing jobs and their opportunities to pursue postsecondary degrees in computer science and other computing-related degrees through flexible education pathways. North Carolina is one of a limited number of states that awards core mathematics graduation credit to rigorous computer science. Education programs in the fundamentals of computer science are available through the statewide career technical education programs, as well as through the North Carolina Virtual Public School. Both the classroom and online course offerings are available to all students.

The content and structure of career technical education pathways in North Carolina are mandated at the state level and build on foundational software applications literacy courses available to middle school students.

High school computer science courses are part of the career technical education programs offered in comprehensive public high schools. Many of those schools also contain career academies in information technology. The career technical education program in information technology offers four pathways: (1) programming and software development, (2) web and digital communications, (3) information support and services, and (4) network systems.

The programming and software development pathway aligns with the *CSTA K–12 Computer Science Standards* recommendations, as well as other national technology curricular standards. Early in the pathway, students take two sequential computer programming courses: Visual Basic and then C# with game development. AP Computer Science is available as a final course option.

To help make AP Computer Science available to all students across the state, AP Computer Science and other computer science courses are also available online through the Virtual Public School and are sometimes taught outside of career technical education programs by mathematics teachers.

The career technical education pathways incorporate workforce-related assessments into their information technology courses, such as including computer programming on relevant final exams or offering aligned industry-recognized technology credentials upon completion of certain courses. Work-based learning opportunities and the senior year internship for students in the information technology career cluster typically take place with local industries in need of computing workers.

For students wishing to pursue postsecondary degrees, the state is readying articulation agreements to provide seamless transitions for K–12 students entering state community colleges and four-year institutions.

North Carolina offers a computer programming endorsement for career technical education teachers in the Business, Finance and Information Technology Education program area. The endorsement also is available as a supplemental teaching endorsement for Marketing Education, Mathematics Education, Technology Education, or Trade and Industrial Education teachers. The endorsement follows the teacher certification recommendations of the Computer Science Teachers Association (CSTA). The requirements for acquiring a computer programming teaching endorsement include coursework in programming, object-oriented programming, data structures, algorithms, and computer architecture. Statewide professional development takes place each summer for North Carolina teachers and aligns with the computer programming teaching endorsement and continuing education requirements.

Assessment of the programming and software development pathway includes formal and informal procedures. Before the programming courses were widely authorized, they were pilot tested in ten schools across the state. The pathway was aligned with the national career technical education clusters and with the Common Core State Standards wherever possible. Each course is accompanied by a detailed Essential Standards Guide based upon Bloom's Taxonomy. Currently, North Carolina is conducting assessments on the end outcomes students acquire when they take industry exams instead of course exams. The preliminary results are positive.

North Carolina's experience suggests a continued trend toward more students taking computer science. AP Computer Science course offerings and enrollment have increased. The number of students in North Carolina taking the AP Computer Science A exam increased roughly 35% between 2011 and 2013, with an increase in the average score as well. Enrollment in computer programming courses also is increasing across a diverse demographic of students.

Exploring Computer Science (ECS)

The Exploring Computer Science program is a multi-pronged approach to embedding computer science in high schools that incorporates flexible certification requirements, professional development, and alignment with national curricular standards.

For information about the program and how it maps to the *CSTA K–12 Computer Science Standards*, visit http://www.exploringcs.org

Los Angeles Unified School District

The Los Angeles Unified School District (LAUSD) is the second largest school district in the United States and ranks among the most diverse in student demographics. The school district is developing several computer science education pathways that build upon the success of its nationally replicated Exploring Computer Science (ECS) program. This program is a multi-pronged approach to embedding computer science in high schools that incorporates flexible certification requirements, extensive professional development, and alignment with national curricular standards. The program targets participation by females, minorities, and other traditionally underrepresented groups in computer science and the computing workforce.

The foundational curriculum is a yearlong course. The course covers such diverse areas as human-computer interaction, web design, introductory programming, computing and data analysis, and robotics. The course has been mapped to the Next Generation Science Standards, and aligns philosophically with the Common Core State Standards for English Language Arts and Mathematics.

In California, the Exploring Computer Science course is taught in academic and career technical education programs. It satisfies California "G" credit as a college preparatory elective. The school district recommends Exploring Computer Science as a foundational skills course for all career technical education in information technology pathways. Efforts are underway, supported by the lead for career technical education in information technology at the California Department of Education, to designate Exploring Computer Science as the foundational course for all career technical education in information technology pathways in the state.

When a high school expresses interest in teaching Exploring Computer Science, the school is provided extensive assistance from a centralized Exploring Computer Science team. This assistance includes two years of mandatory professional development, instructional materials, and inquiry-based pedagogical support. Teachers also receive assistance from the centralized team when working with local education leaders, raising awareness among a variety of stakeholders, and developing context-sensitive assessment measures. The professional development model has enabled and motivated teachers from content areas as diverse as the social sciences and humanities to teach Exploring Computer Science.

The Exploring Computer Science program is producing tangible results in expanding and broadening participation in computer science. Since its launch in 2008, the program has reached roughly 6,000 students in 35 high schools in Los Angeles.

Demographic figures are encouraging: Hispanics/Latinos represent 77% of all students taking Exploring Computer Science, and Blacks/African Americans represent 9%. These percentages are close to the percentages each group represents in the school district's student population as a whole. Females represent 43% of the Exploring Computer Science students. The success of the course at achieving its diversity goals and creating enthusiasm for computer science has been highlighted in education journal articles and has been documented in reports generated by an external assessment firm.

To capitalize on student enthusiasm and provide the next step on the pathways to the workforce or postsecondary degrees, the Exploring Computer Science team is creating linkages in academic and career technical education programs to other college preparatory coursework. The Exploring Computer Science team is working with partners in the school district to create new computer science courses that build upon the Exploring Computer Science course. These new options likely will include the AP Computer Science Principles course or specialty courses in the student's particular area of interest. In preparation, the Exploring Computer Science program is offering professional development geared toward preparing teachers for AP Computer Science Principles.

Chicago Public Schools

Chicago's first ever technology plan, titled *The City of Chicago Technology Plan* and released in 2013, identifies expanded student access to STEM education as critical for innovation, job creation, and quality of life. Under Initiative 8, the City will work with the Chicago Public Schools to integrate computer science as part of the core curriculum. The plan's vision includes increasing student access to computer science courses, especially AP Computer Science, and allowing students to count computer science courses toward core graduation requirements, possibly in mathematics or science.

The Chicago Public School system, the nation's third largest school district, has already established a baseline for computer science courses. The Exploring Computer Science (ECS) course is the foundational first course for all eight career technical education programs in information technology. As a result of the Exploring Computer Science requirement, every information technology student is exposed to rigorous computer science early in high school. Exploring Computer Science courses are open to all students.

Students who take an Exploring Computer Science course have a range of computer science education pathways. For example, career technical education students have the option of choosing courses that will satisfy academic requirements necessary to enter programs offered by city colleges. Students then have the option of transferring from the two-year city colleges to four-year institutions.

Three courses of Chicago's career technical education program in information technology provide preparation for postsecondary computer science and other computing-related bachelor's degrees: *Computer Programming* (found in six high schools), *Oracle/Database Programming* (found in five high schools), and *Game Programming* (found in twelve high schools). These courses include coverage of basic programming concepts using languages such as Java and C++, introductory data structures, and the software development lifecycle. Chicago also has five STEM-focused high schools. These STEM schools contain career technical education tracks in information technology strands and are creating unique articulation agreements with two-year and four-year postsecondary institutions.

Because Exploring Computer Science is a foundational course, all information technology teachers attend the extensive professional development for Exploring Computer Science. Any teacher who takes part in the professional development for Exploring Computer Science can also receive continuing education credit from DePaul University. Teachers are enthusiastic about their experience with Exploring Computer Science.

Enthusiasm for computer science education is growing in Illinois. There is an expanding community of teachers who report that they talk extensively about pedagogical innovation when they attend meetings and conferences. As a result of becoming involved in teaching computer science, Illinois teachers submitted an application for statewide membership in the Computer Science Teachers Association (CSTA).

Education leaders, industry leaders, and policymakers in Illinois are developing productive coalitions in support of computer science education. Representatives from high schools, colleges, and the state's technology industry communicate regularly with each other about the status of initiatives such as outreach, standards generation and assessment, mentoring, and workforce readiness.

Alabama

Alabama's computer science education initiatives are gaining statewide and national attention. Alabama is demonstrating that a holistic approach to computer science education can be highly effective in a state where a large number of high schools are in rural areas with many disadvantaged students. A team of computer scientists based at the University of Alabama is successfully integrating a blend of formal and informal computer science initiatives into middle schools and high schools across the state. As a result of these diverse yet integrated activities, a growing number of Alabama students have access to more rigorous computer science courses. Further, starting in the 2014-2015 academic year, students will be able to count Computer Science Principles and Advanced Placement (AP) Computer Science A as a mathematics credit for high school graduation.

Computer science summer camp is the first step of the pathway for many Alabama middle or high school students. The University of Alabama team offers up to four weeks of camp each summer (one middle school week and three high school weeks), structured as independent experiences with progressively more advanced computer science concepts and skills. In the high school sequence, students can take one, two, or all three weeks. Students with prior computer science experience can start with the second or third week. A typical three-week sequence consists of Java followed by robotics, and concludes with a week building Android mobile apps.

The computer science summer camps are extremely popular. Far more students request a place than the team can accommodate, even as Alabama teachers take over more and more of the activities from the University of Alabama team. Girls make up 50% of the middle school camps and 15% to 20% of the high school camps. Students from across the United States and abroad participate in the camps. In 2012, 90 students from 13 states, as well as Hong Kong and Beijing, participated.

Participation in computer science summer camp can lead to student projects during the academic year. The University of Alabama team works with individual schools to find the best way for each school to support the continuation of student projects. Students receive a stipend if they sign an agreement to continue working on their projects. They then receive remote and in-person mentoring throughout the year in preparation for science fairs. These efforts have helped several students qualify for the Alabama Science and Engineering Fair each year and four students qualify as finalists at the Intel International Science and Engineering Fair.

Robotics and programming clubs are another way computer science is being introduced into Alabama schools. The University of Alabama team works with schools to set up the clubs, providing support as needed. Tuscaloosa provides a good example of strategic planning to ensure student access to computer science clubs in Alabama schools. Tuscaloosa City Schools have a large number of students from underrepresented groups, many of whom are on free/reduced lunches. Often, these students must go home immediately after school lets out for the day. Tuscaloosa City Schools approved the inclusion of computer science programs during a daytime club period when all students have the opportunity to participate. Club participants work on a variety of computer science projects and have the option of taking part in statewide competitions.

The Alabama Robotics Competition, started in 2011 by the University of Alabama, is open to all K–12 students with prizes and awards at different grade levels. The competitions are highly popular. In 2013, 32 teams from 32 schools participated. The results indicate the clubs and competitions are reaching a broad demographic of Alabama students. In the 2012 competition, an inner-city team of Black/African American students from Birmingham beat out teams from several statewide mathematics/science magnet schools.

Academic coursework is yet another part of the Alabama computer science education strategy. The University of Alabama team gained national attention when it became one of the official pilot institutions to implement the AP Computer Science Principles (AP CSP) course into high schools during the academic year 2011–2012. Since then, AP Computer Science Principles continues to be integrated into academic and career technical education programs, reaching more than 400 students in 10 schools. The University of Alabama is partnering with ten teachers to train an additional 50 teachers to teach the new AP Computer Science Principles course by the 2016-2017 school year. The first AP Computer Science Principles exam will be administered in May 2017. The ten teacher trainers are taking over many of the program and support activities. Four trainers are from academic programs; six are from the career technical education programs.

Plans are underway to supplement classroom offerings of AP Computer Science Principles with online offerings through the Alabama online system available to any high school student. When this happens, AP Computer Science Principles will join the AP Computer Science course, which is already available online.

Bringing computer science to the most rural areas of the state is the most recent phase of the computer science education initiative in Alabama. Alabama locates rural career technical education centers across the state, offering a variety of courses to students living in remote districts. Rural centers began offering the AP Computer Science Principles course in 2013.

Establishing a personal connection and building trust with all participants has been critical to the success of Alabama's computer science education efforts. Established teachers are offered professional development and mentoring during the summer, with follow-up support during the school year. Enthusiasm for computer science professional development is high and has led to Alabama teachers receiving a statewide CSTA chapter in summer 2013. In some programs, students serve as peer mentors, with some students beginning in the 6th grade. Guidance counselors are included in outreach efforts.

Sustainability strategies include targeting new teachers to teach computer science, lead clubs, and teach camp programs. College undergraduates majoring in mathematics education are teamed with computer science undergraduates. Starting in 2013, a special section of Computer Science Principles will be offered to the pre-service mathematics education students, which will introduce them to Computer Science Principles and enable them to fulfill a requirement that they complete a computer science course.

Utah

Many states in the United States are in the early stages of evaluating ways to incorporate computer science into K–12 education. These states can look to Utah for inspiration about ways to get started creating their own computer science pathways.

Taking advantage of an existing computer literacy requirement can be an effective approach for getting an initial foothold for K–12 computer science education. Utah, like many states, has a computer literacy requirement for high school graduation. Starting with a small number of high schools, Utah swapped out some sections of the computer literacy class in favor of a half year of Exploring Computer Science (ECS)[†]. Using this approach, no new teachers or resources were needed. As the modified course has proven itself, more Utah high schools are introducing it.

Utah is leveraging the fact that, as in many other states, computer science courses are currently taught in career technical education programs. By virtue of being located in the career technical education programs, it is easier for teachers with a related teaching credential to obtain a state teaching endorsement for Exploring Computer Science. The establishment of this teaching endorsement can serve as a first step to creating a professional teacher certification system for computer science teachers.

The initial case for incorporating parts of the Exploring Computer Science course included its national recognition, documented student success, and the extensive support available to implement it. Additional evidence came after students in the Exploring Computer Science pilot course easily passed the end-of-course computer literacy skills test used in the original course. In another pilot course, students with a wide range of abilities demonstrated that they were motivated by the material and successful in acquiring computer science concepts. In that pilot course, student abilities ranged from those with prior programming experience to those learning English, as well as those with learning challenges.

In Utah, as in other states that have implemented the Exploring Computer Science program, initial reactions by students and teachers have been positive. Teachers from a wide variety of subject areas are excited about the prospect of teaching the Exploring Computer Science course in their classrooms. In addition, a core group of teachers is forming that will run future professional development workshops.

In the 2013-2014 school year, students at 20 high schools have the option of taking Exploring Computer

[†] See the profile of the Los Angeles Unified School District for a discussion of ECS.

Science and having it satisfy the state's mandatory computer literacy requirement. To increase teaching capacity so the course can be offered at more schools, the Utah Exploring Computer Science Initiative aims to train and support 100 Exploring Computer Science teachers by 2015. The Initiative receives funding from the National Science Foundation.

With growing demand for computer science courses, educators are starting to ask about what comes next for students interested in computer science education pathways. The AP Computer Science Principles course is being discussed as that next course. The College Board will administer the new AP Computer Science Principles exam in May 2017. Further, efforts are underway to bolster support for AP Computer Science Principles by having it recognized as a means for satisfying a core high school graduation requirement in mathematics or as an elective credit, similar to AP Computer Science.

Kentucky

The Kentucky Community and Technical College System is one model for providing effective and diverse articulation pathways to bachelor's degree programs. Colleges in the system are leveraging state education directives and forming relationships among themselves to reduce barriers to transferring computer science courses across two-year and four-year postsecondary institutions.

Kentucky community college students have two primary pathways for obtaining computer science and computing-related bachelor's degrees. One route leads first to a Computers and Information Technology Applied Associate of Science (AAS) degree, while the other route leads first to an Associate of Science (AS) degree. The Computers and Information Technology Applied Associate of Science degree offers seven tracks, including computer science, information security, and programming. The Associate of Science degree is a transfer degree with a concentration in computer science.

Rigorous computer science courses are available in both degree programs. Course topics include Java or C++ programming, algorithms and introductory data structures, introductory software engineering, and discrete mathematics. Assuming the student receives a grade of C or above, these courses are guaranteed to equate to computer science courses at the University of Kentucky, as well as at many other public and private four-year universities in Kentucky. Students who are awarded the Associate of Science degree with a concentration in computer science are also guaranteed to have satisfied all pre-major requirements in the University of Kentucky's computer science program. Additional articulation agreements for transferring computer science courses across Kentucky's community colleges and four-year institutions are well under way.

To help implement community college courses that will count toward the lower-division requirements for a computer science or computing-related major at public universities, the faculty at Kentucky community colleges regularly communicate with the universities and with each other, sharing course materials, resources, and experiences.

For example, faculty from the Bluegrass Community and Technical College meet in person with faculty from the University of Kentucky to discuss courses and articulation agreements. Faculty then share their experiences of working with the University of Kentucky with the other community and technical colleges in Kentucky.

Kentucky has taken other steps to ease the transfer of computer science courses across community colleges and universities. Frequently, university faculty serve on Computer Information Technology (CIT) advisory boards to help guide the two-year computer science curriculum. Some of the community and technical colleges, as well as some universities, provide on-campus transfer centers to assist students with transferring from two-year to four-year institutions. For example, the Bluegrass Community and Technical College's Transfer Center serves students in all degree programs and contains dedicated office space for full-time transfer advisors from many of Kentucky's public and private four-year institutions.

Computer science students have greatly benefitted from this proactive relationship building between community colleges and four-year institutions in Kentucky. Barriers to transfer are down, easing completion of computer science and other computing-related bachelor's degrees. A diverse, often disadvantaged, demographic of students has a greater opportunity to complete a bachelor's degree and join the computing workforce.

Appendix: State-by-State Reports

- About the State-by-State Reports
- State Reports

About the State-by-State Reports

Researchers gathered education and workforce data from the 50 states and the District of Columbia for 2012. Each state report provides computing jobs and salary data, the number of postsecondary certificates and degrees awarded, and the number of high school students taking the Advanced Placement (AP) Computer Science A exam. Each state report also includes whether the state education standards clearly allow a rigorous computer science course to count as a core high school graduation requirement in mathematics or science.

Employment and Salary Data

Computing occupations are defined to include the occupational group of "computer occupations," as well as "computer and information systems managers" and "computer hardware engineers," as reported by the U.S. Bureau of Labor Statistics. This report relies on employment data provided by the federal government to allow for consistent comparisons across a standard set of computing occupations. Although each state publishes current and long-term employment data, the states vary in how they define occupational categories.

K–12 Graduation Requirements

The scope of K–12 graduation requirements includes whether computer science courses clearly satisfy a core high school graduation requirement in mathematics or science, as reported in *Bugs in the System: Computer Science Teacher Certification in the U.S.*, published in 2013 by the Computer Science Teachers Association. After that report was published, Alabama, Tennessee, and Wisconsin in 2013 joined the states that allow computer science courses to satisfy a core high school graduation requirement.

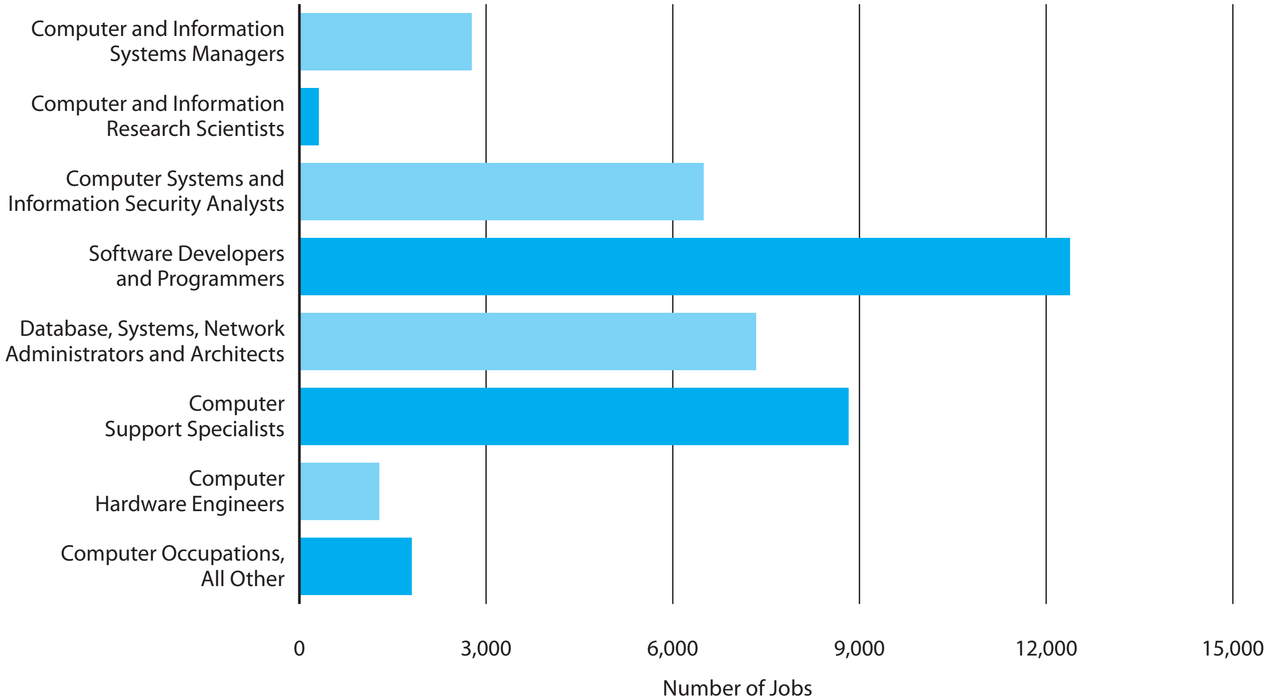
Advanced Placement Exam Data

The Advanced Placement (AP) exam data from the College Board are categorized into computer science and four subject groupings. English includes: English Language and Composition, and English Literature and Composition. History includes: European History, United States History, and World History. Social Sciences include: Comparative Government and Politics, Human Geography, Macroeconomics, Microeconomics, Psychology, and United States Government and Politics. "Other subjects" includes all AP exams in subjects not included in the other categories.

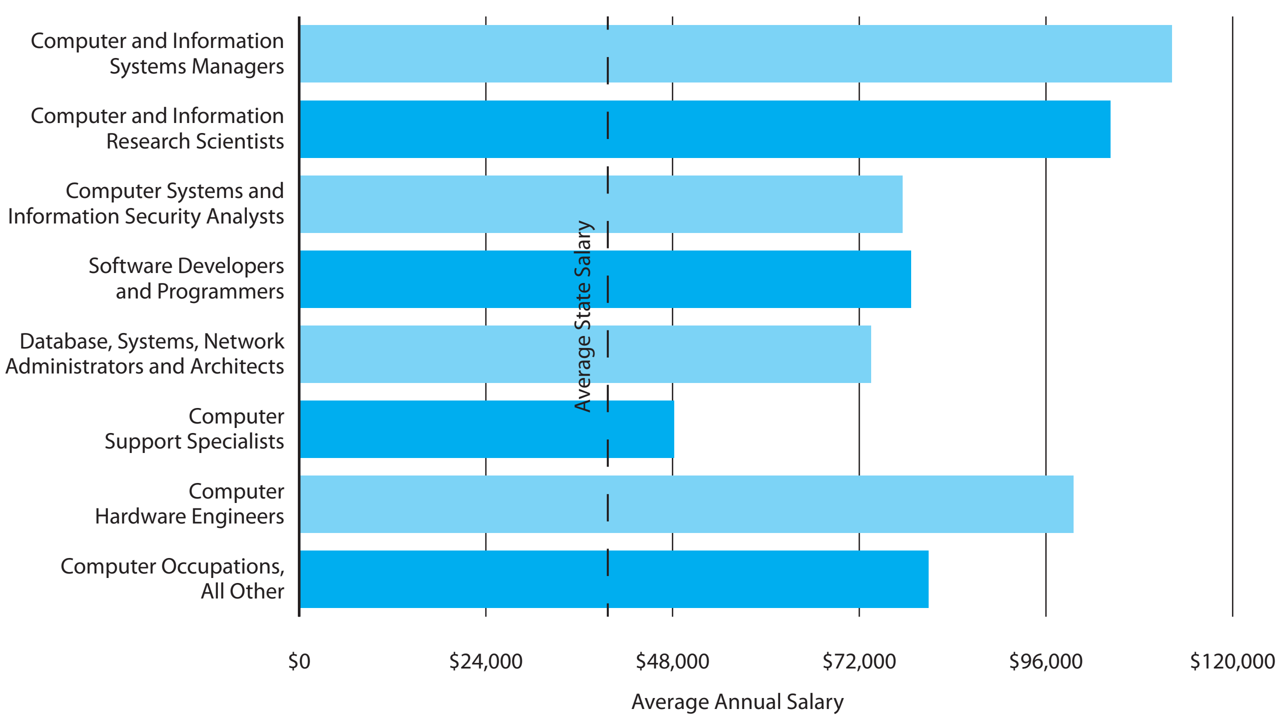
Postsecondary Certificates and Degrees

The number of postsecondary certificates and degrees was obtained from the U.S. Department of Education's Integrated Postsecondary Education Data System (IPEDS) and includes completions between July 2011 and July 2012 for "computer and information sciences and support services" and "computer engineering," which includes software developers and computer hardware engineering. Certificates and degrees from online-only programs offered by private, for-profit institutions are not included. Degrees combining other subjects with computer science and classified within other disciplines, including those classified as interdisciplinary degrees, are not included.

Total Employment in Computing in Alabama in 2012



Average Annual Salaries in Computing in Alabama in 2012



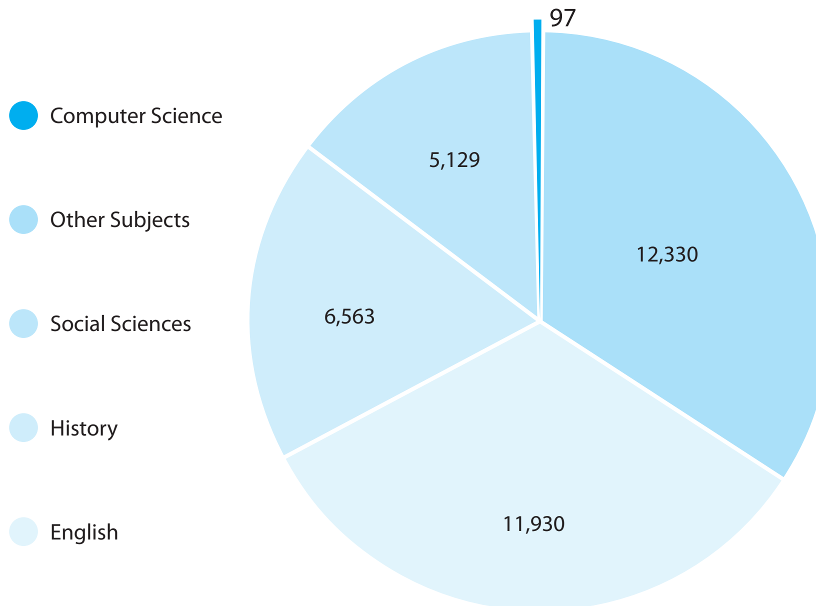
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Alabama

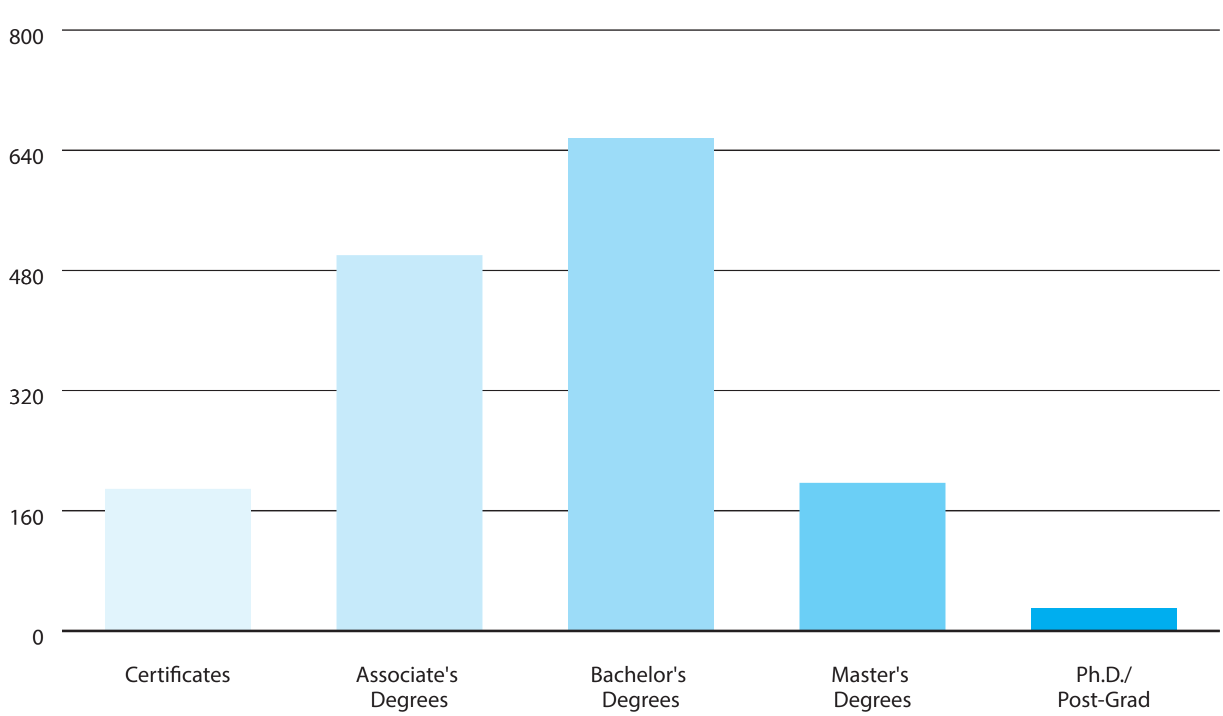
High School Graduation Requirements

Alabama clearly allows computer science to satisfy a core high school graduation requirement in mathematics.

Advanced Placement Exams in Alabama in 2012

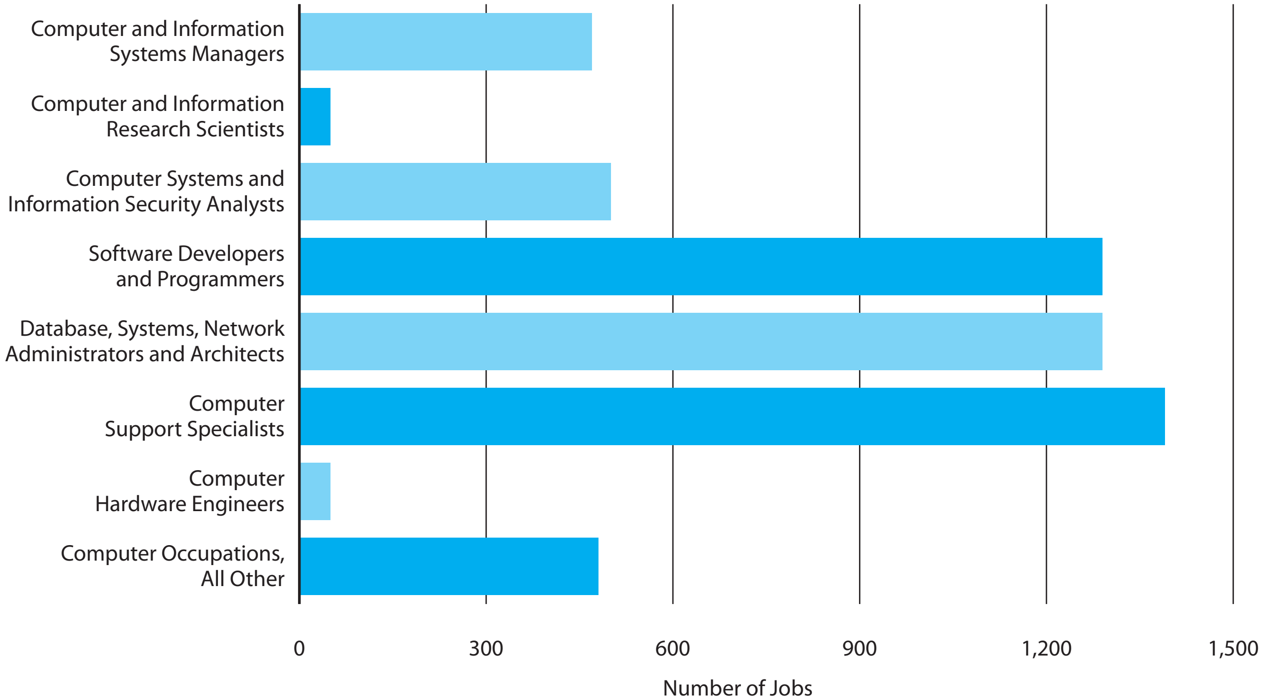


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Alabama in 2012

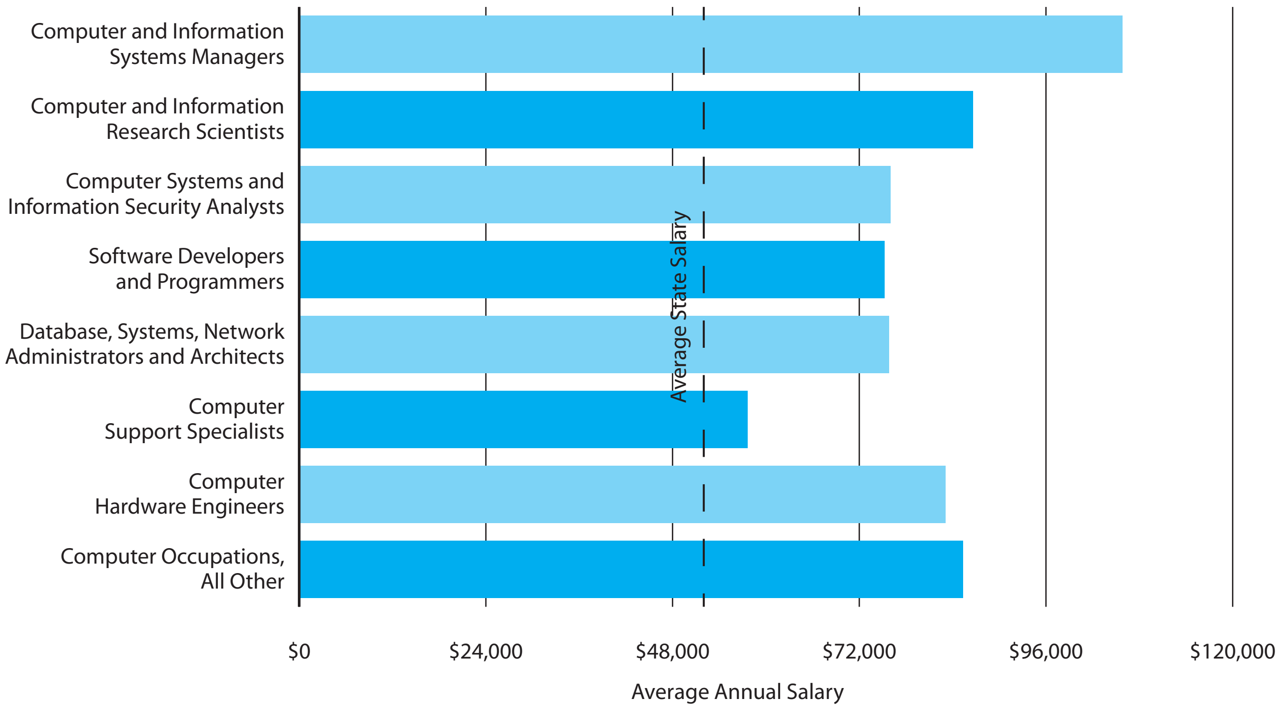


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Alaska in 2012



Average Annual Salaries in Computing in Alaska in 2012



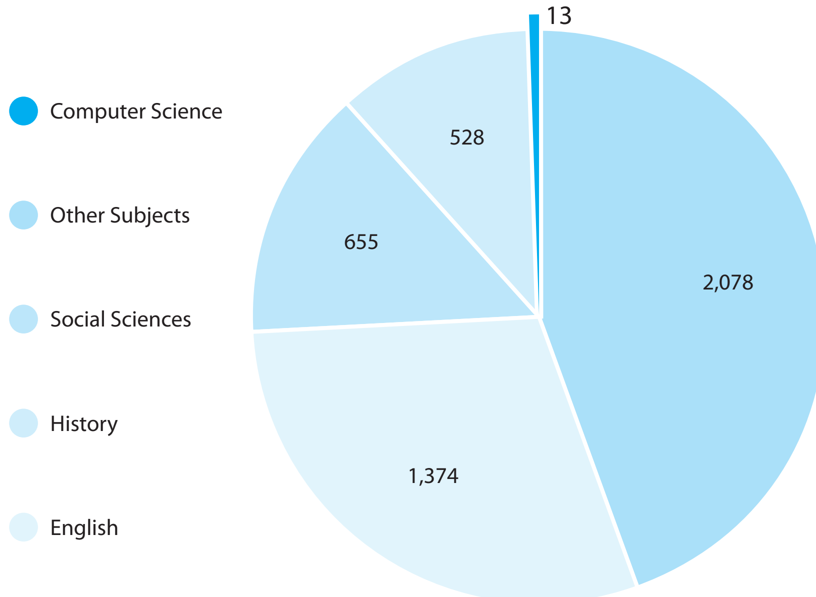
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Alaska

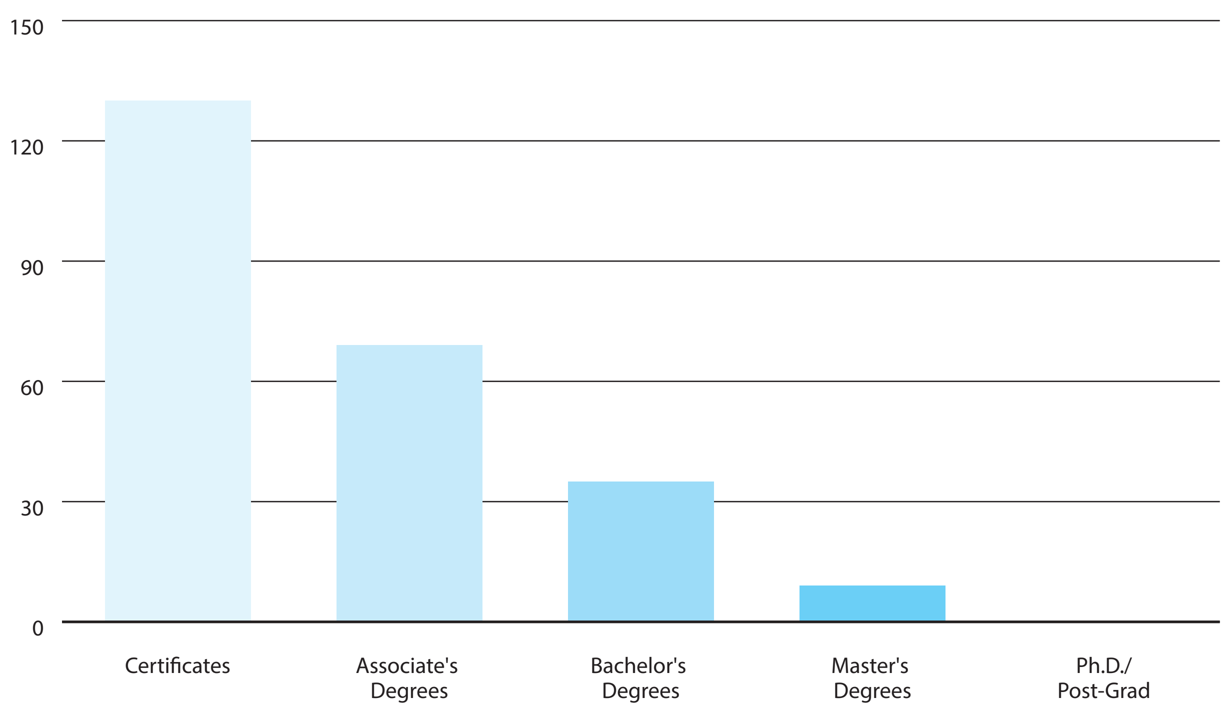
High School Graduation Requirements

Alaska does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Alaska in 2012

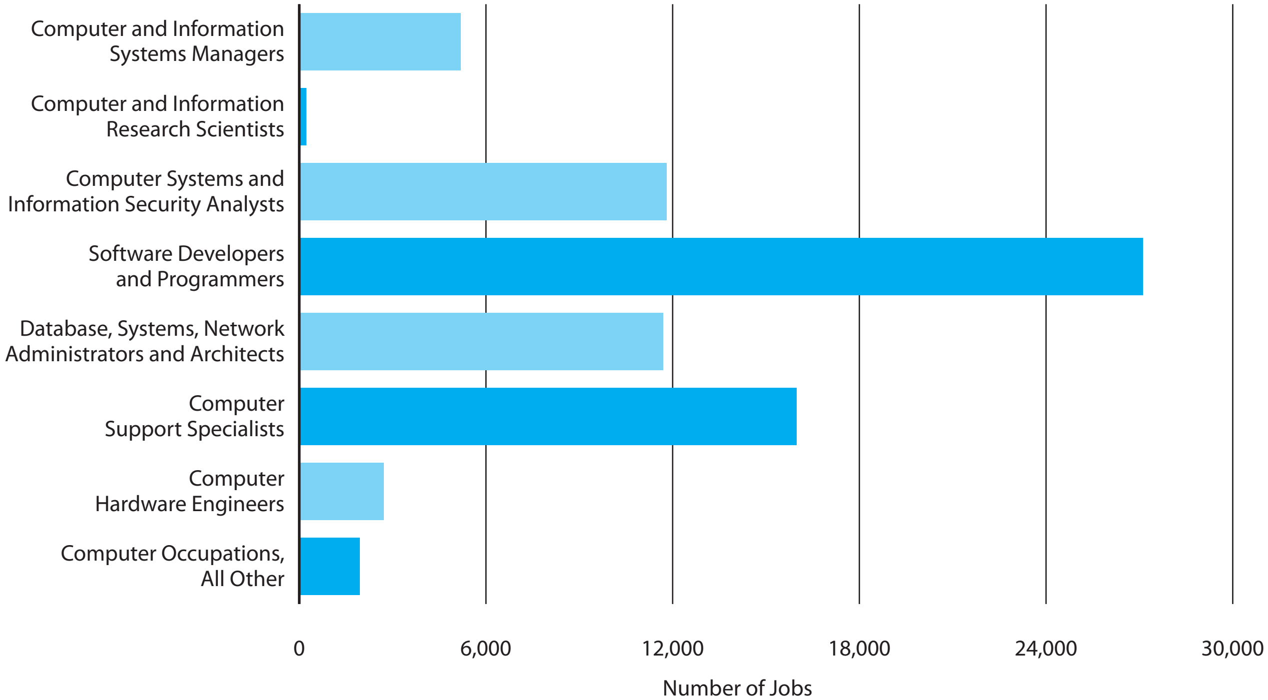


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Alaska in 2012

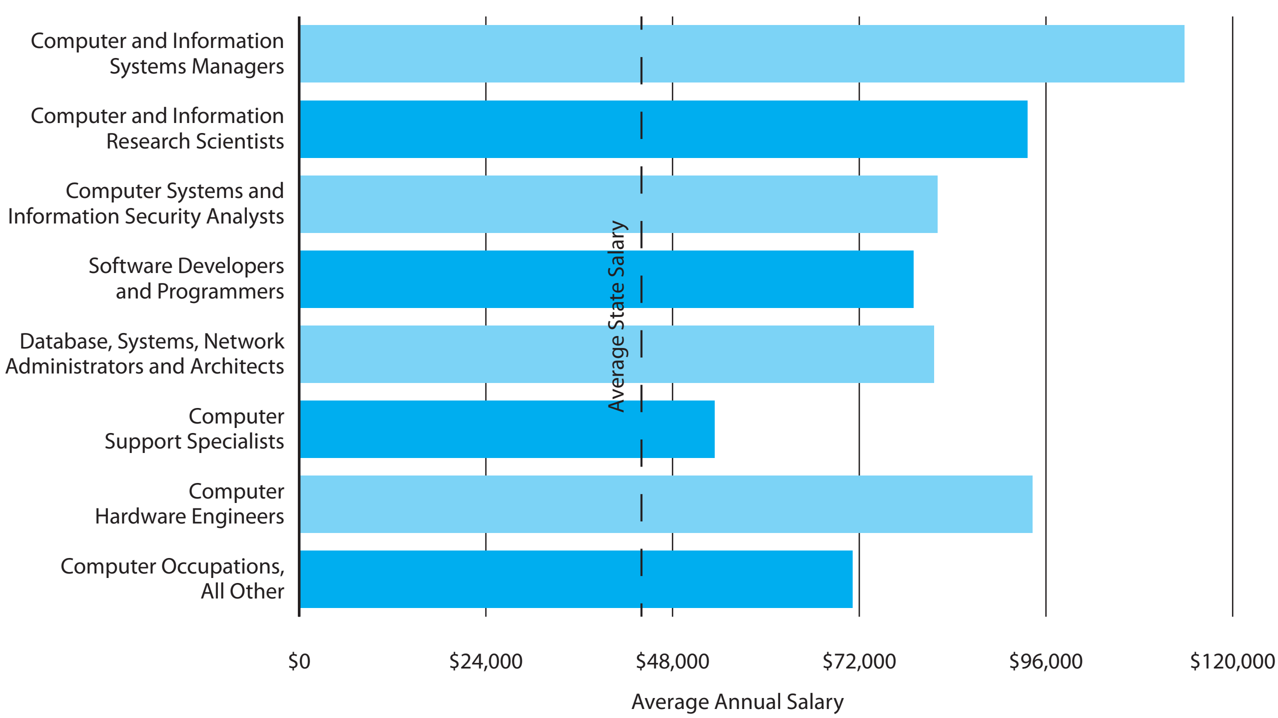


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Arizona in 2012



Average Annual Salaries in Computing in Arizona in 2012



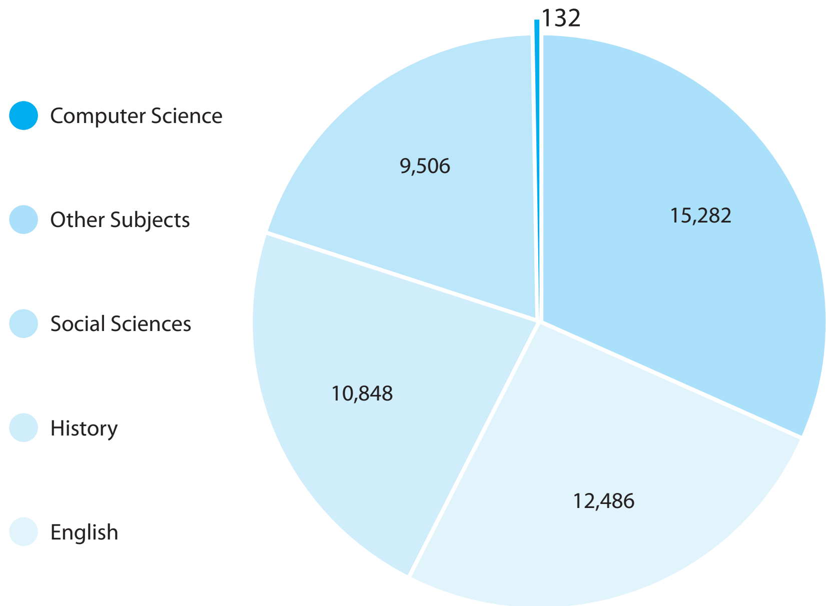
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Arizona

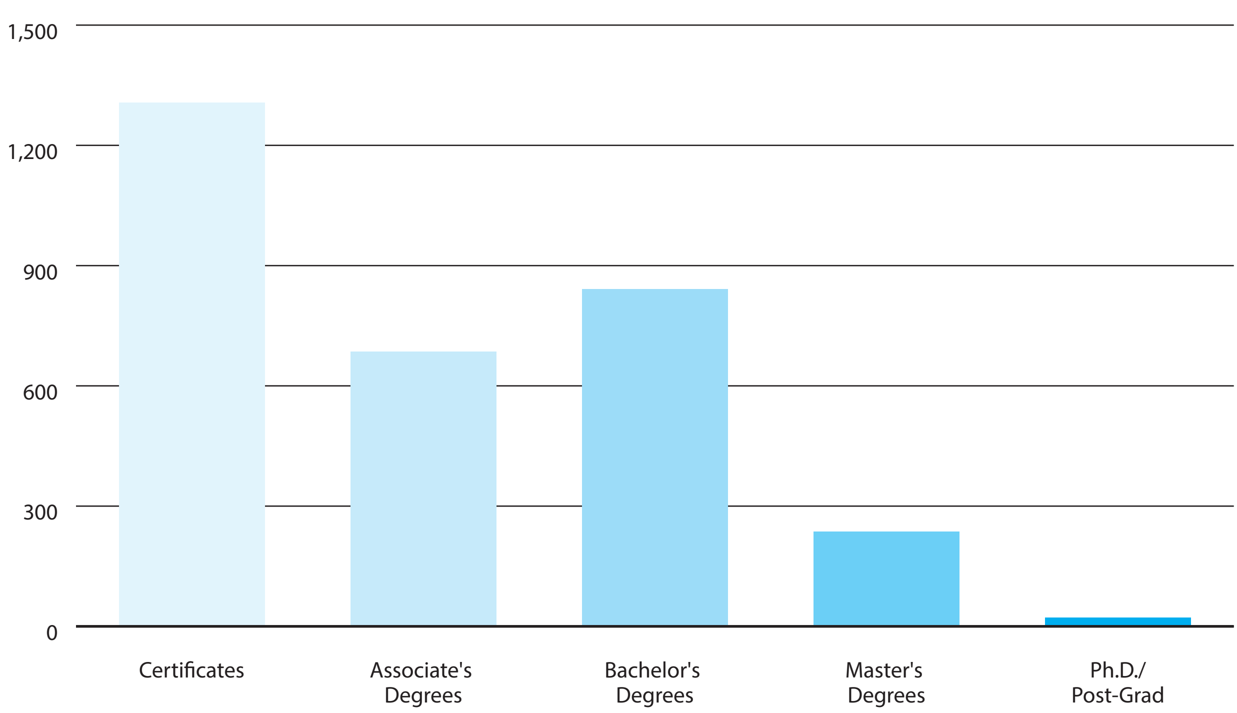
High School Graduation Requirements

Arizona does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Arizona in 2012

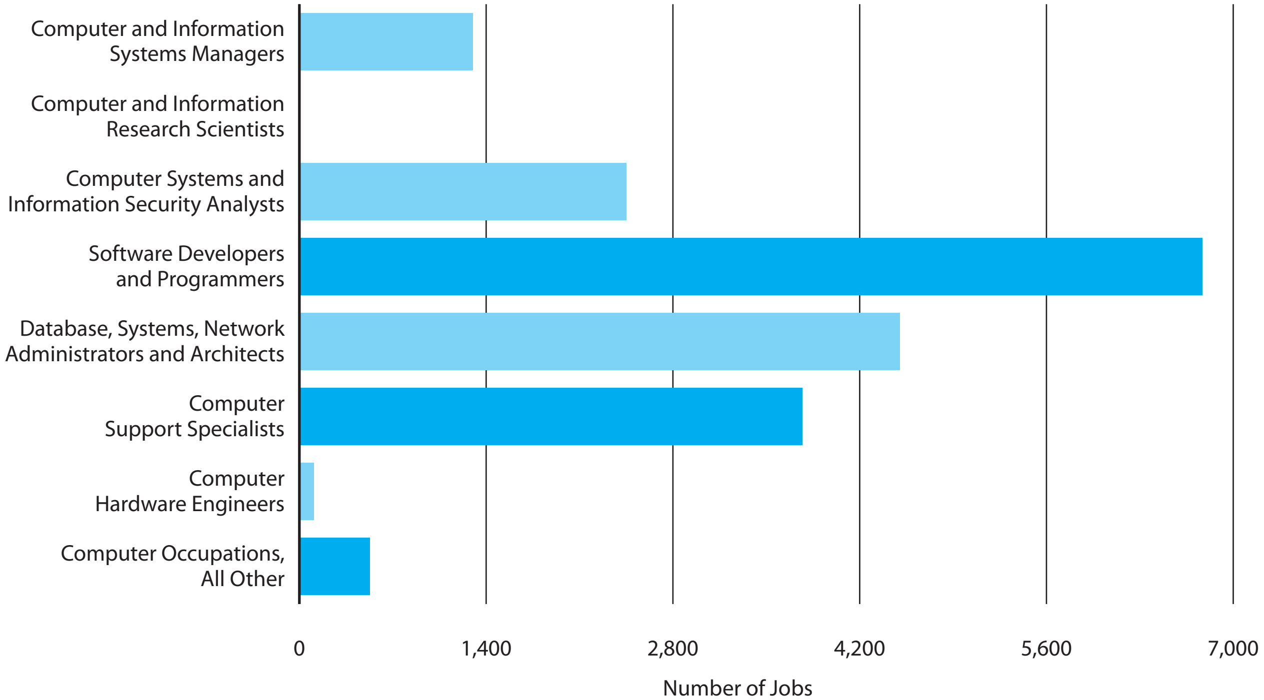


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Arizona in 2012

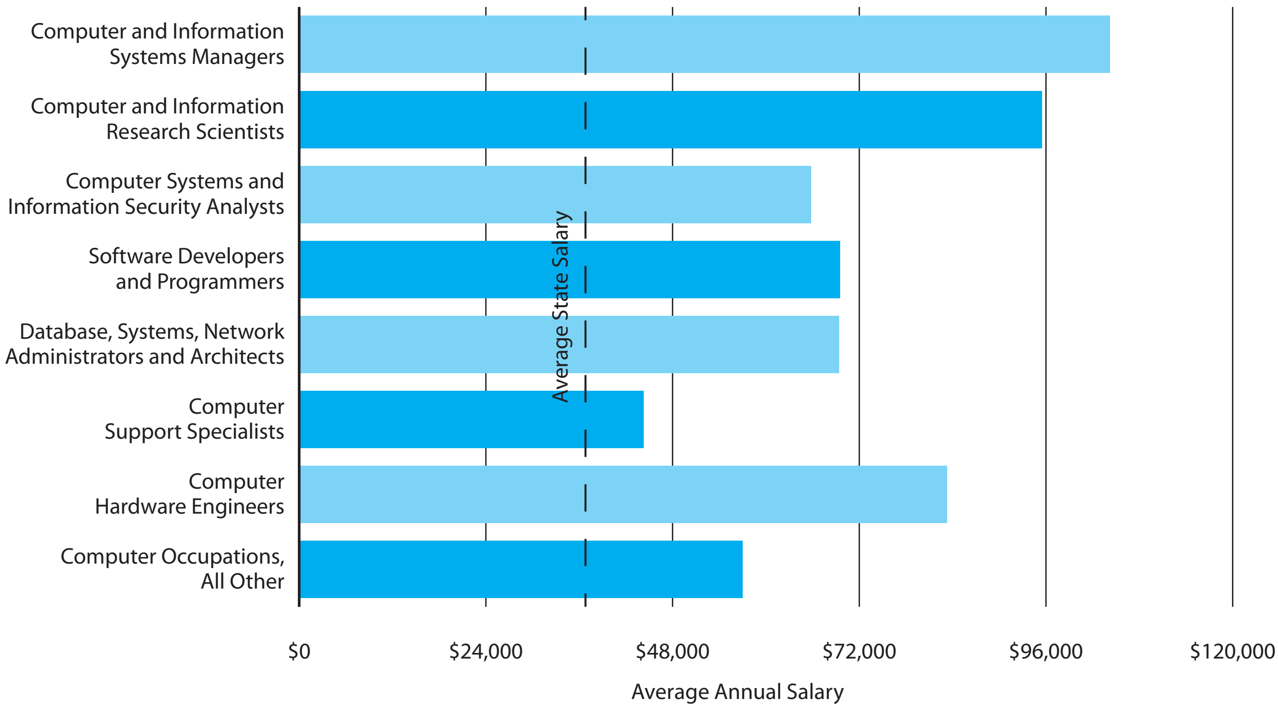


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Arkansas in 2012



Average Annual Salaries in Computing in Arkansas in 2012



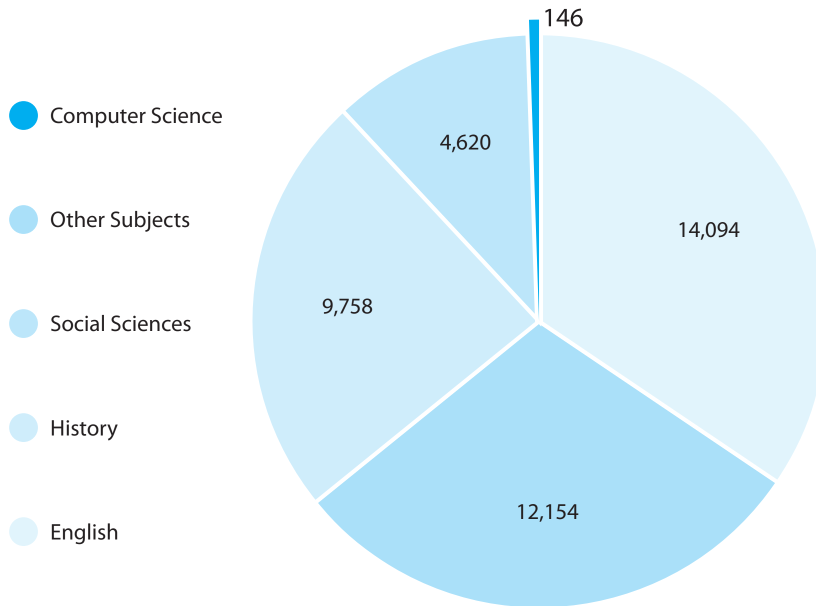
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Arkansas

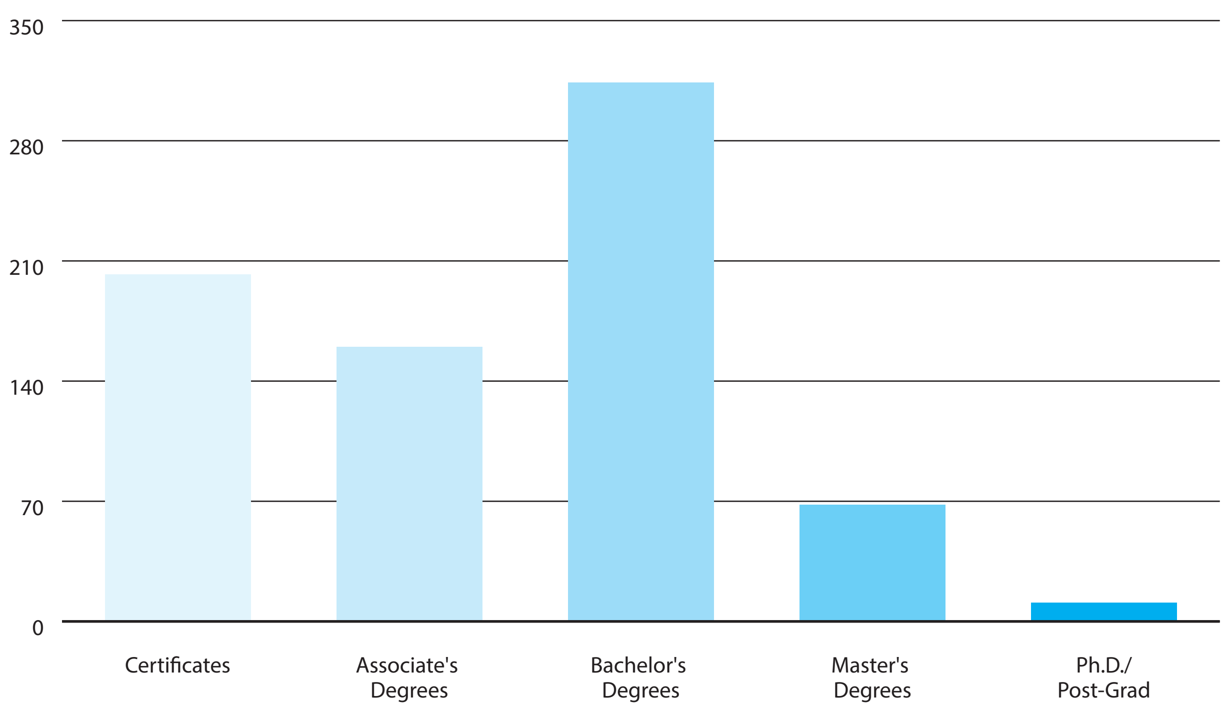
High School Graduation Requirements

Arkansas does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Arkansas in 2012

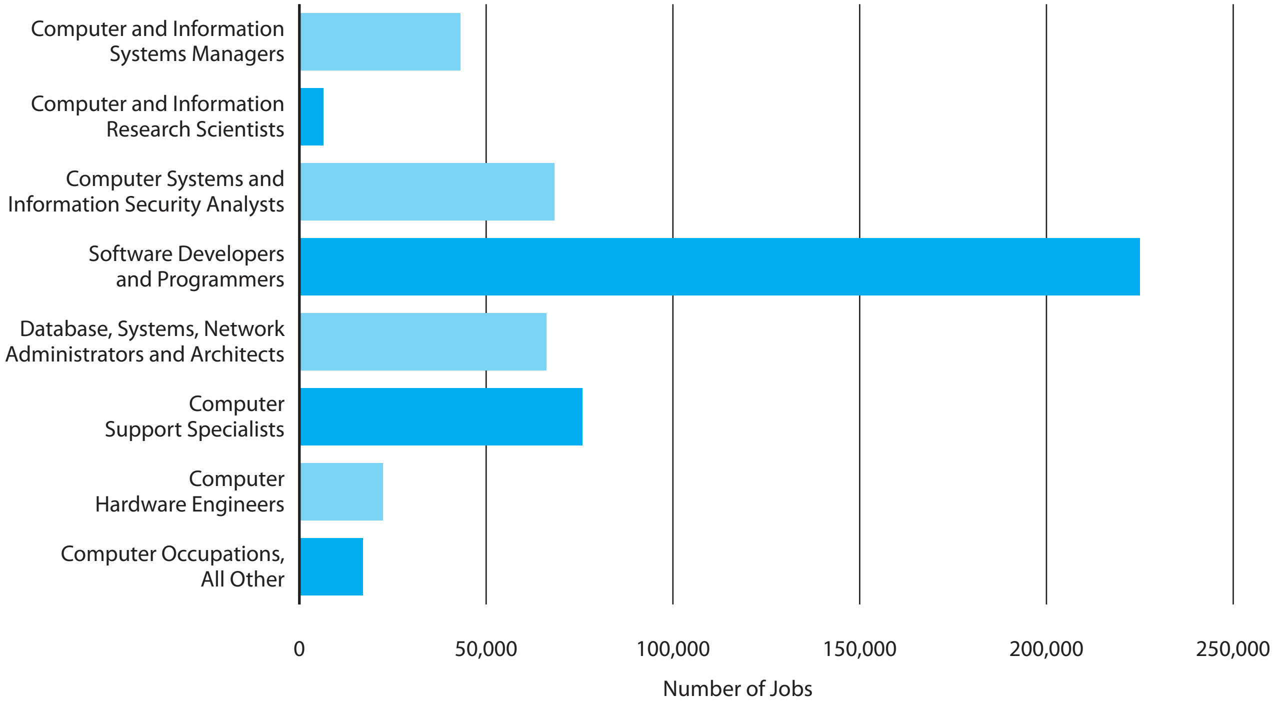


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Arkansas in 2012

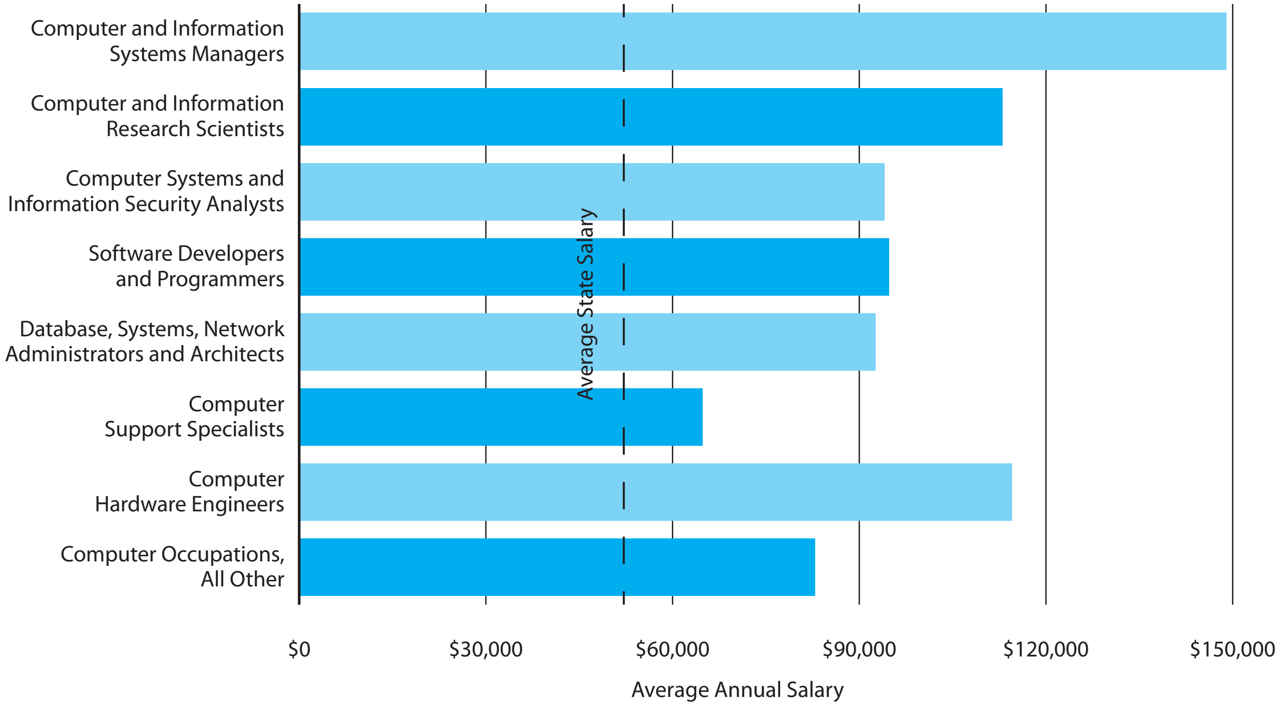


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in California in 2012



Average Annual Salaries in Computing in California in 2012



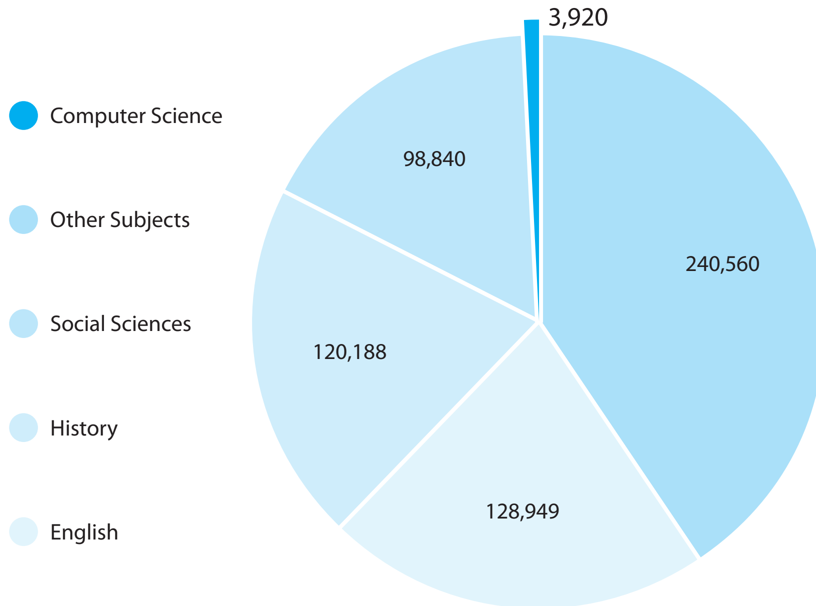
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

California

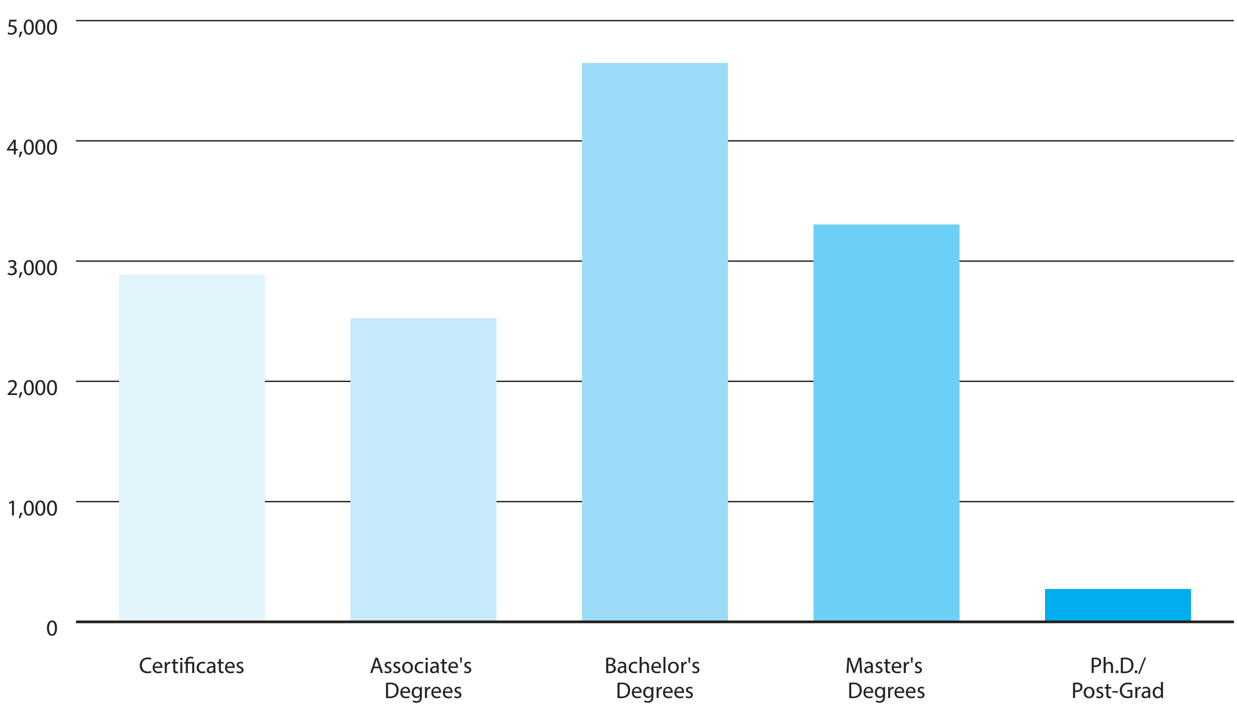
High School Graduation Requirements

California does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in California in 2012

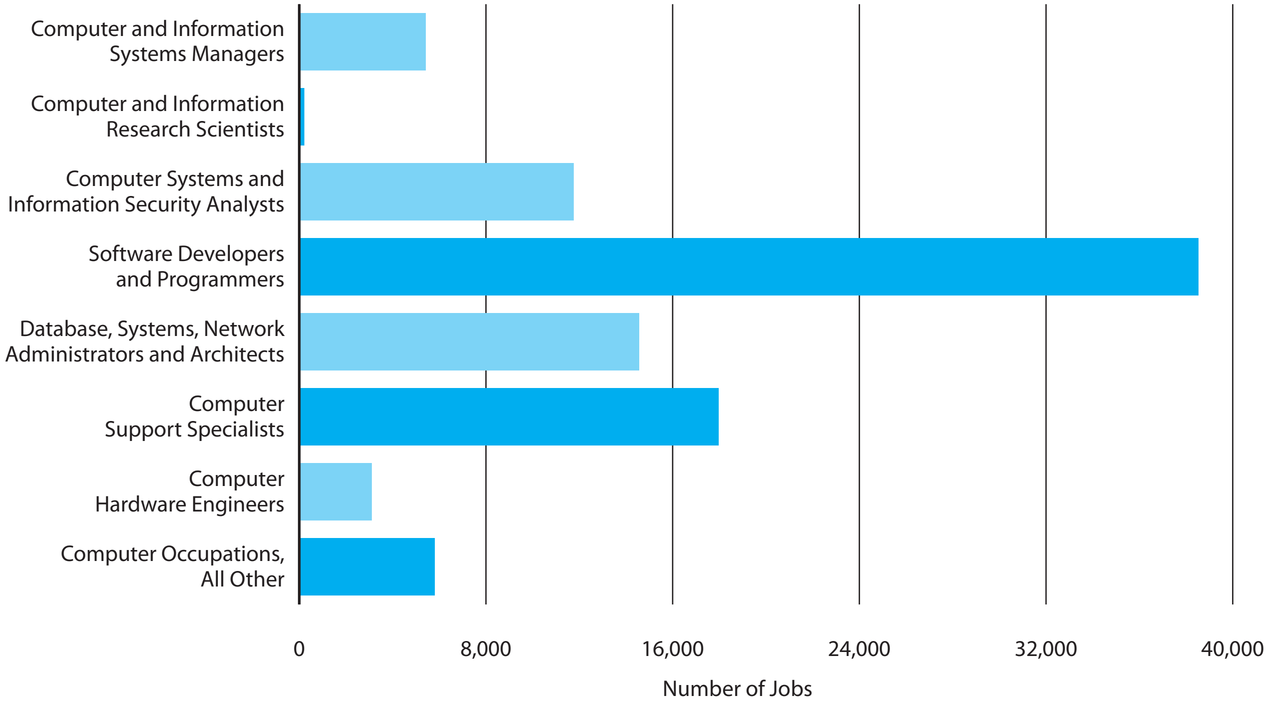


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in California in 2012

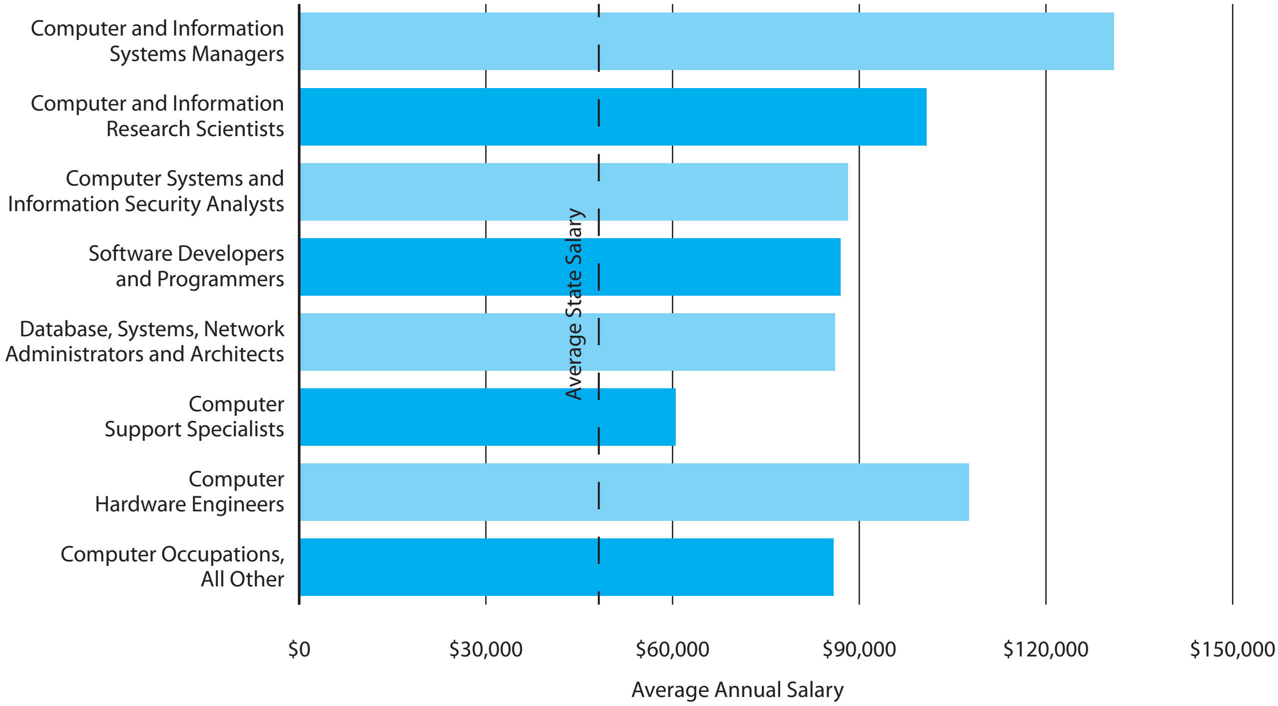


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Colorado in 2012



Average Annual Salaries in Computing in Colorado in 2012



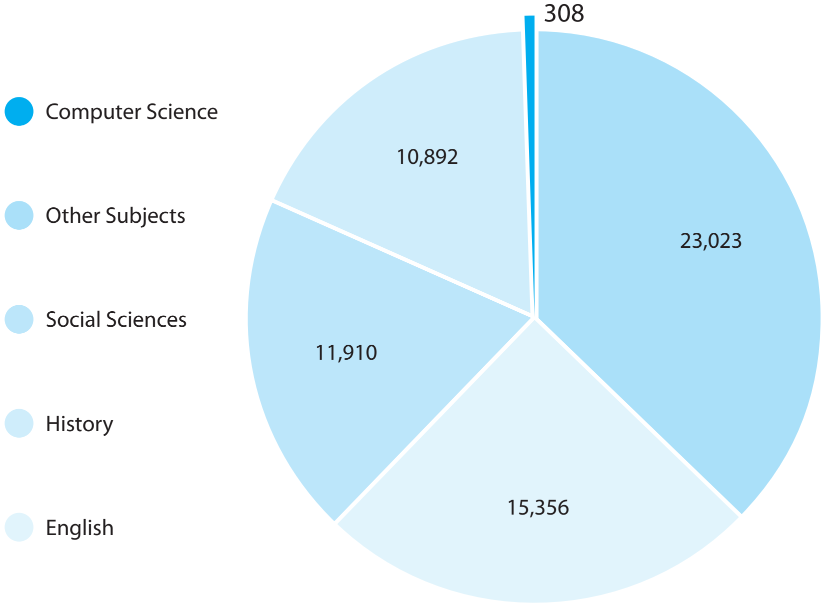
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Colorado

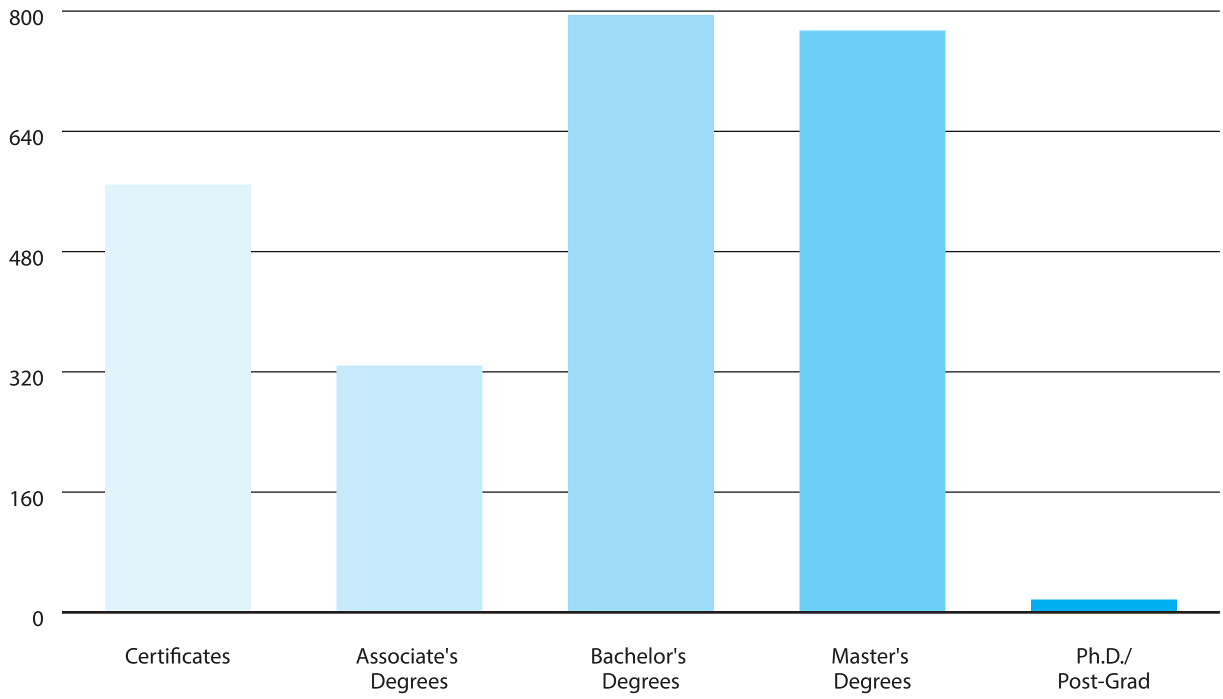
High School Graduation Requirements

Colorado does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Colorado in 2012

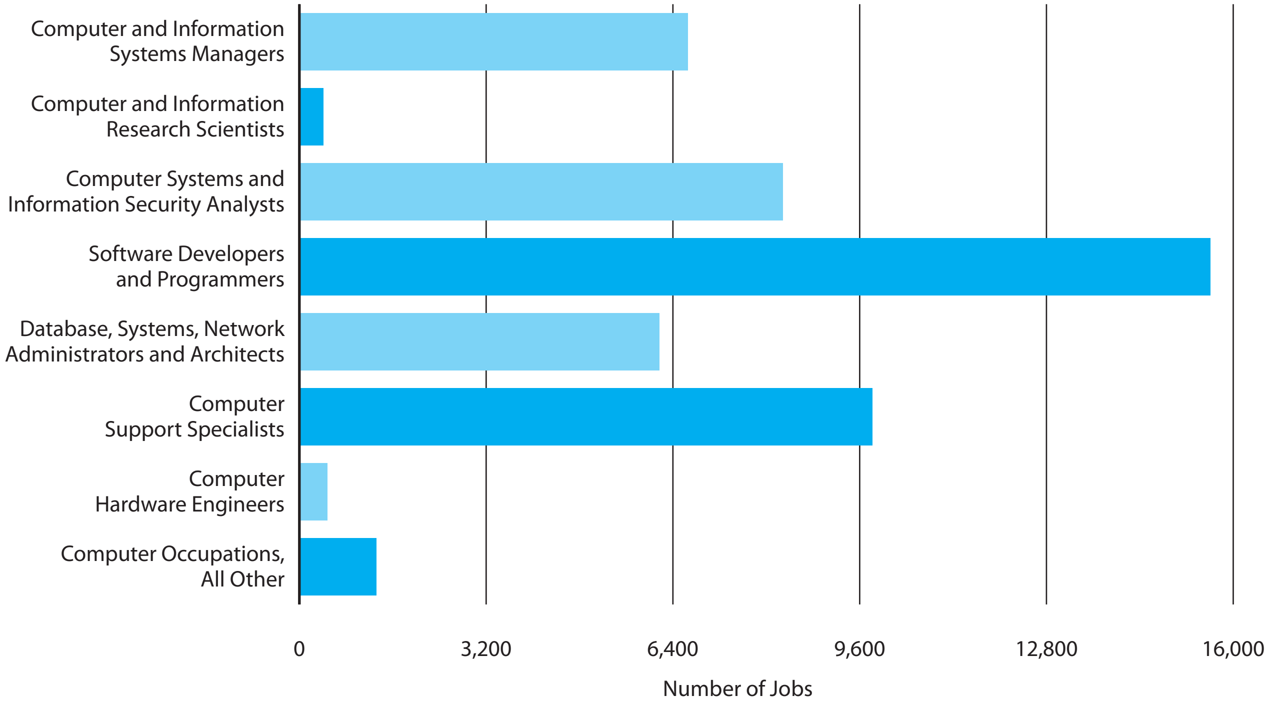


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Colorado in 2012

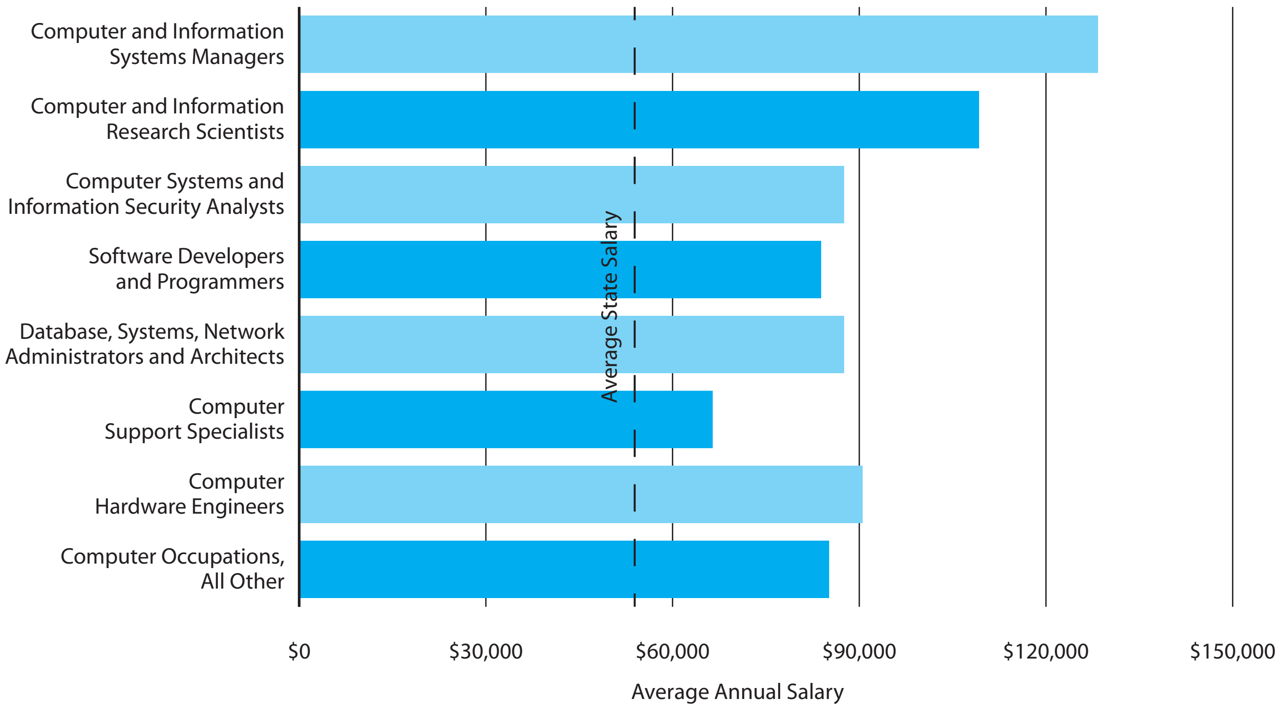


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Connecticut in 2012



Average Annual Salaries in Computing in Connecticut in 2012



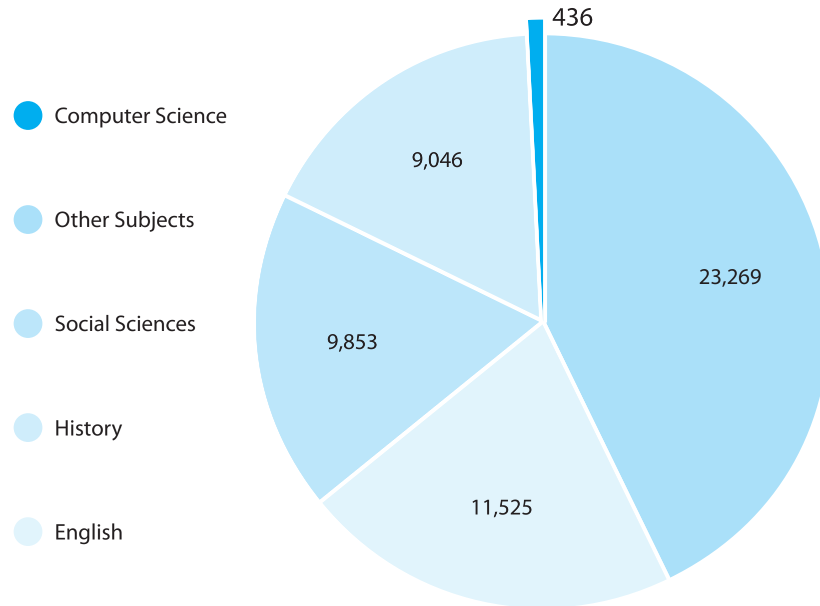
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Connecticut

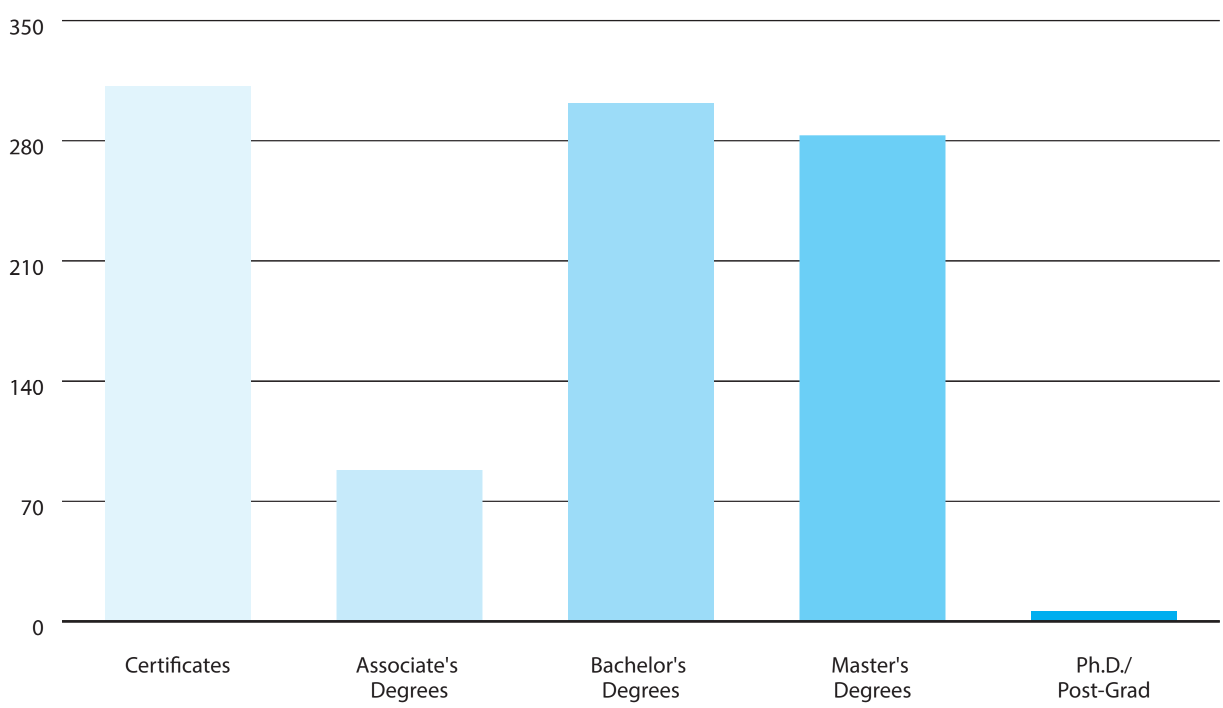
High School Graduation Requirements

Connecticut does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Connecticut in 2012

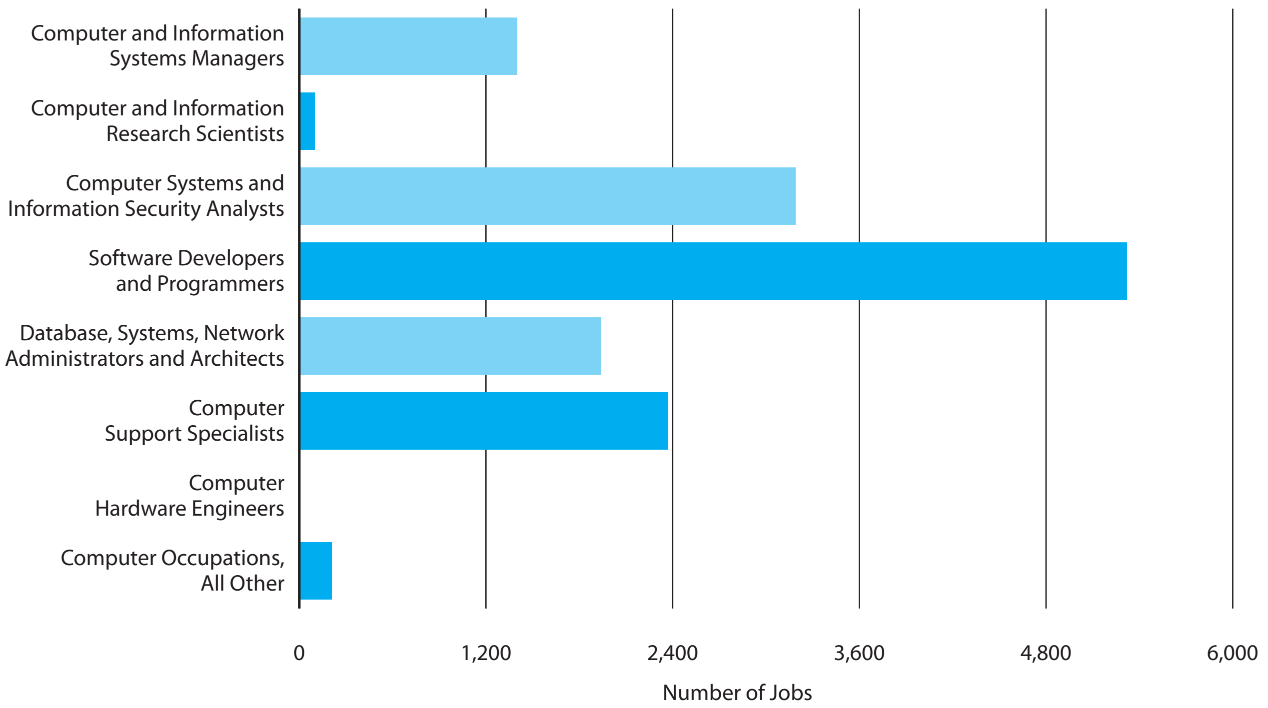


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Connecticut in 2012

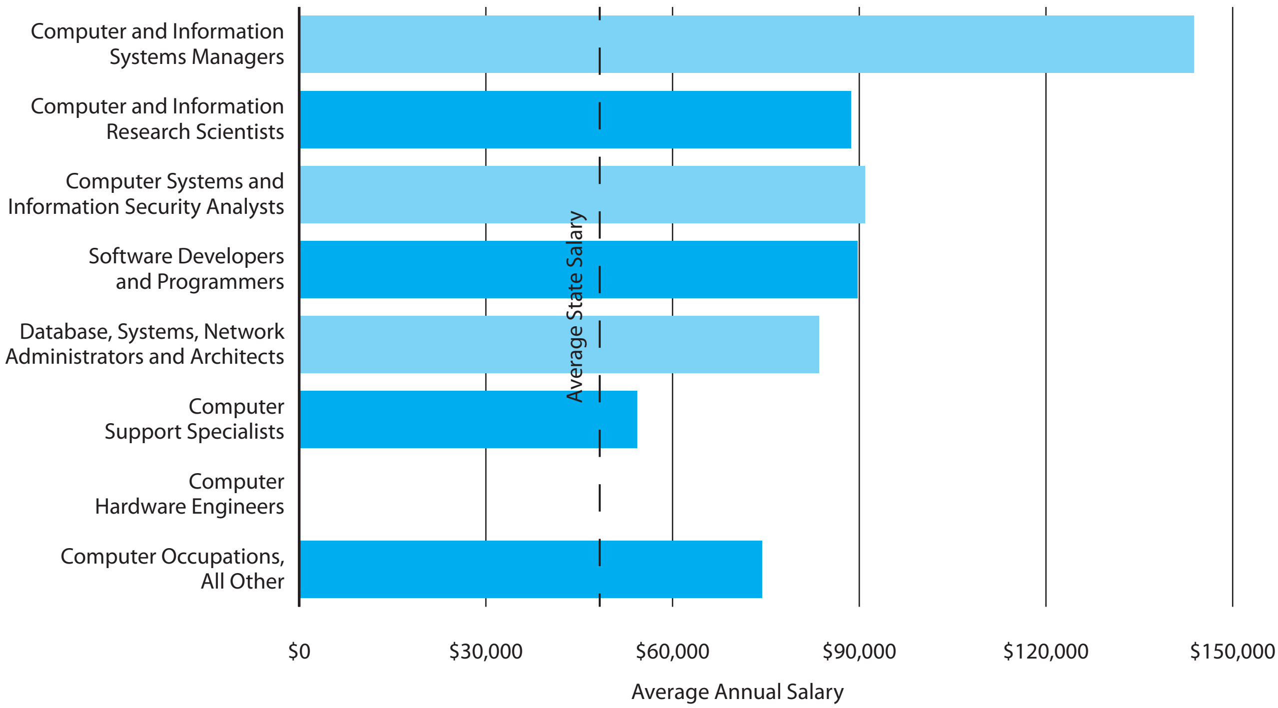


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Delaware in 2012



Average Annual Salaries in Computing in Delaware in 2012



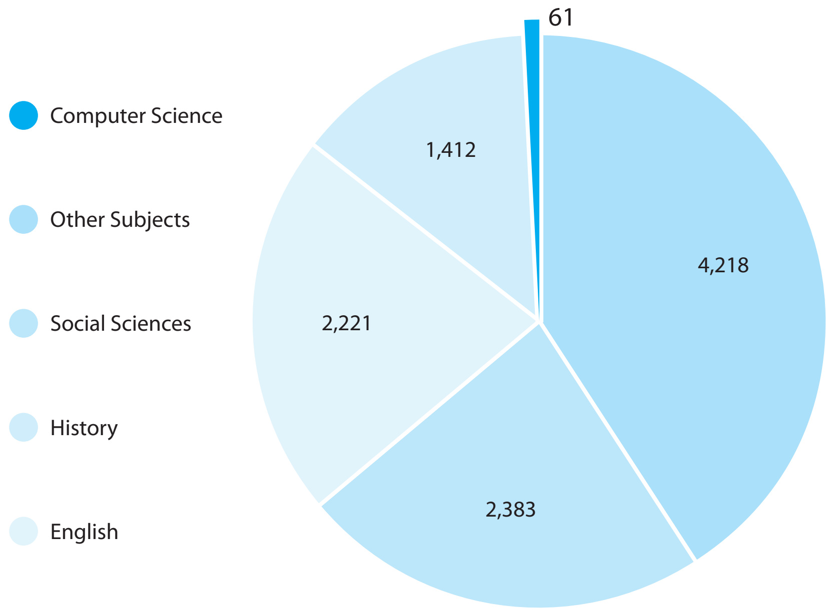
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Delaware

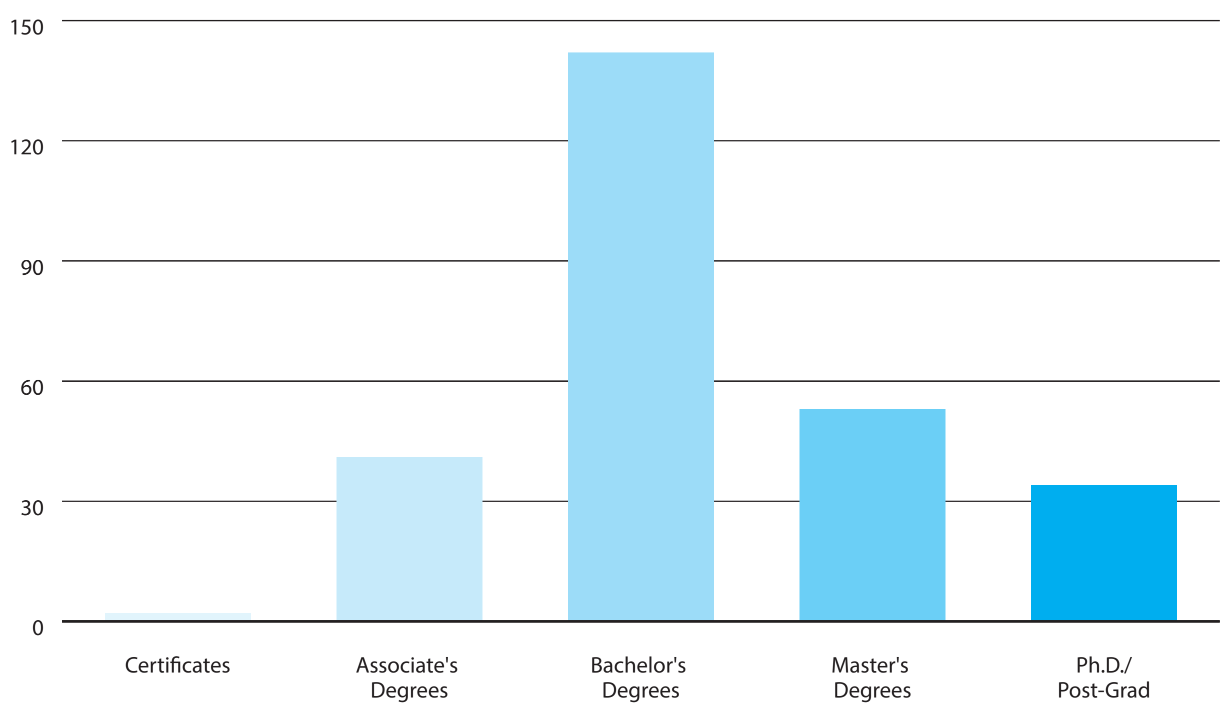
High School Graduation Requirements

Delaware does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Delaware in 2012

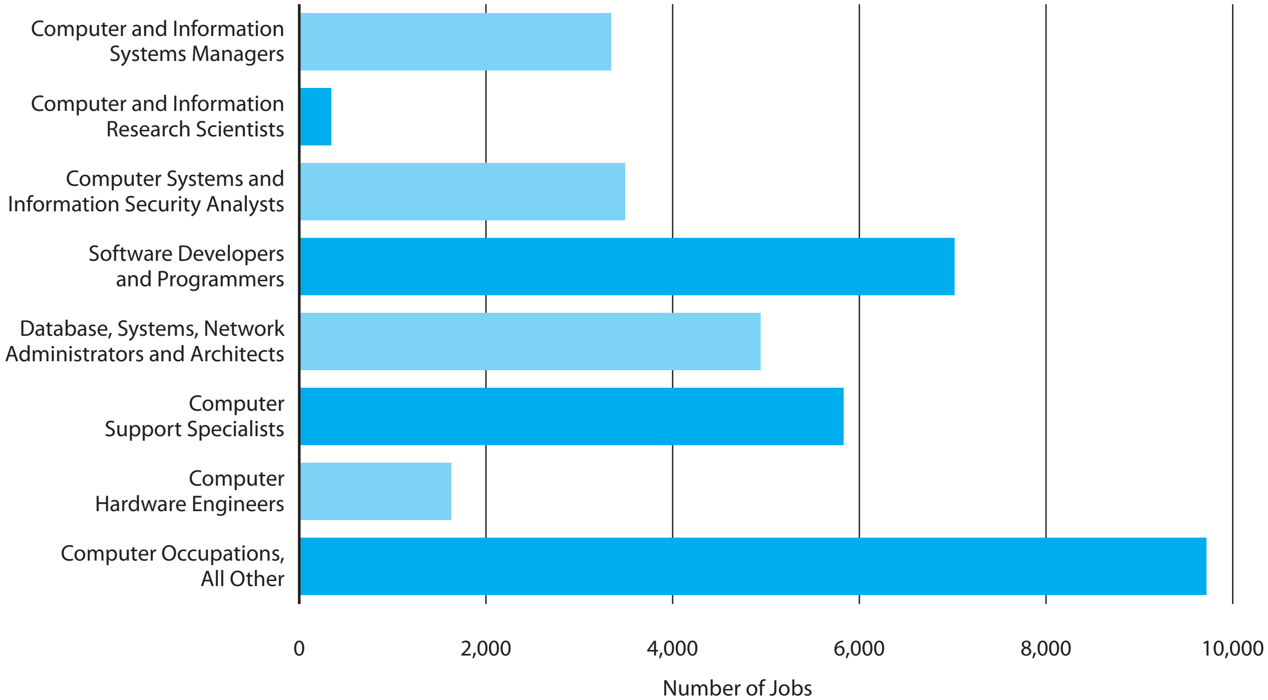


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Delaware in 2012

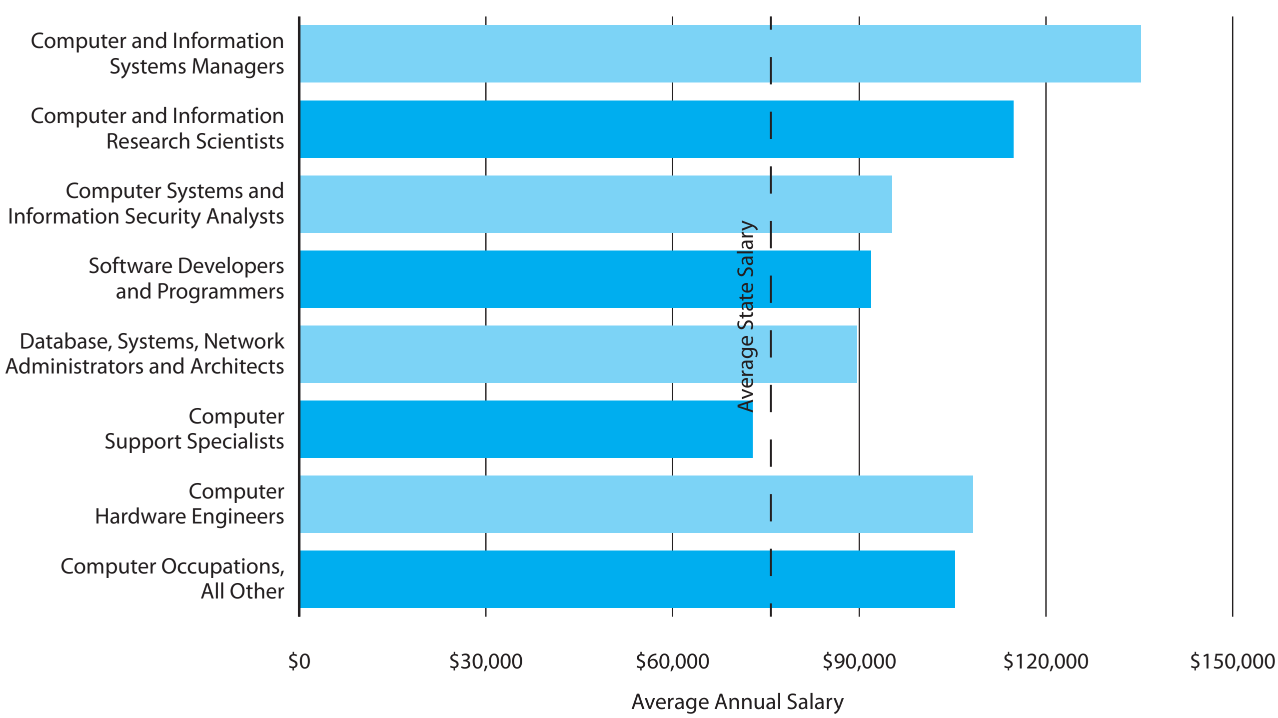


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in District of Columbia in 2012



Average Annual Salaries in Computing in District of Columbia in 2012



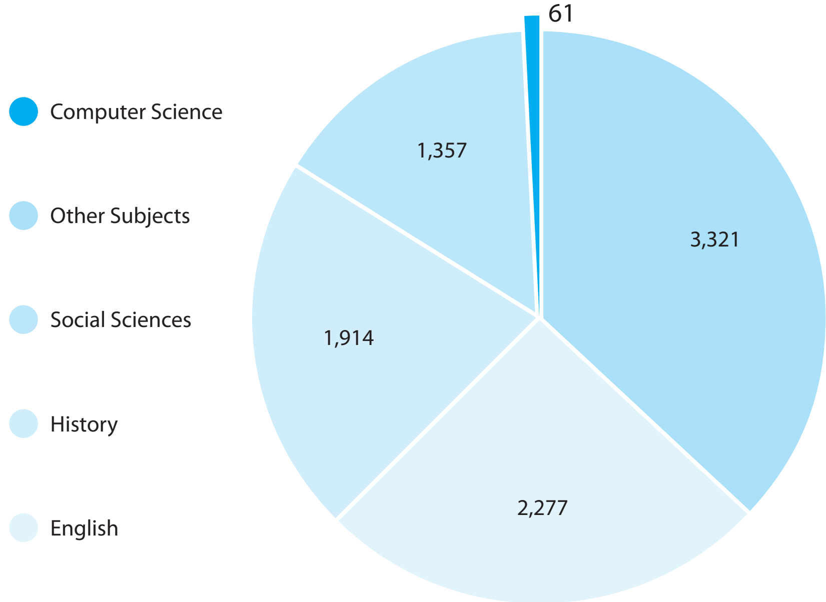
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

District of Columbia

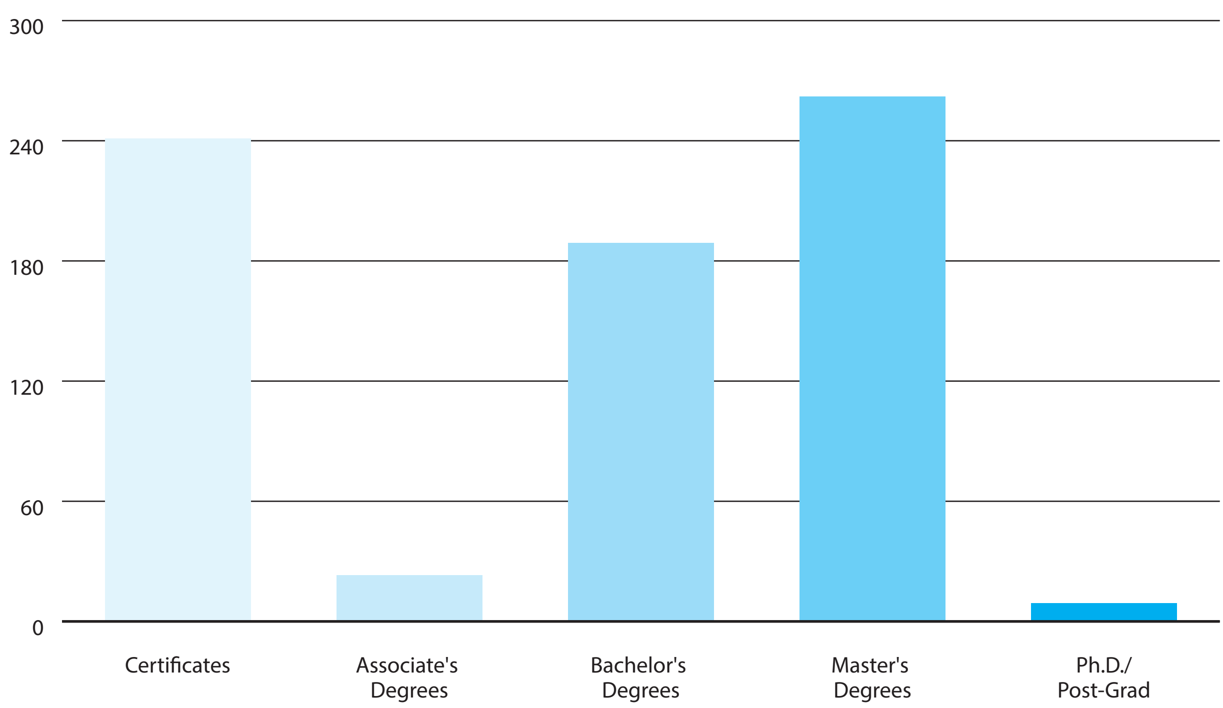
High School Graduation Requirements

The District of Columbia clearly allows computer science to satisfy a core high school graduation requirement in mathematics.

Advanced Placement Exams in District of Columbia in 2012

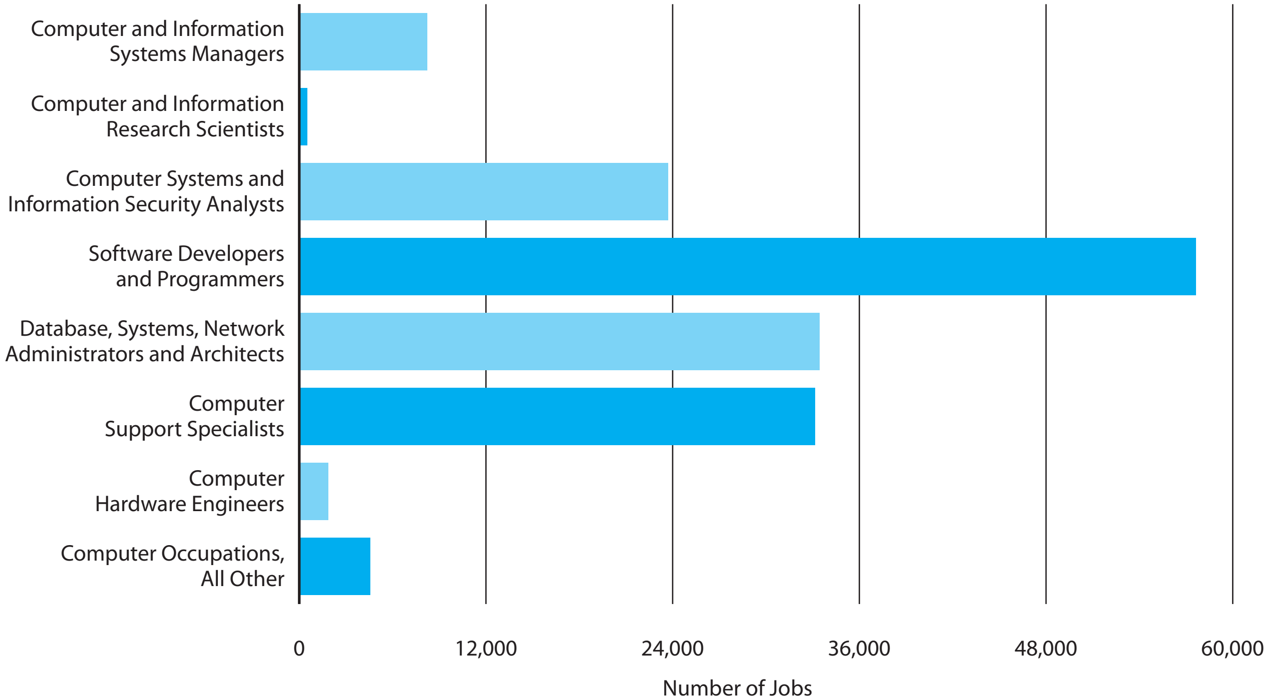


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in District of Columbia in 2012

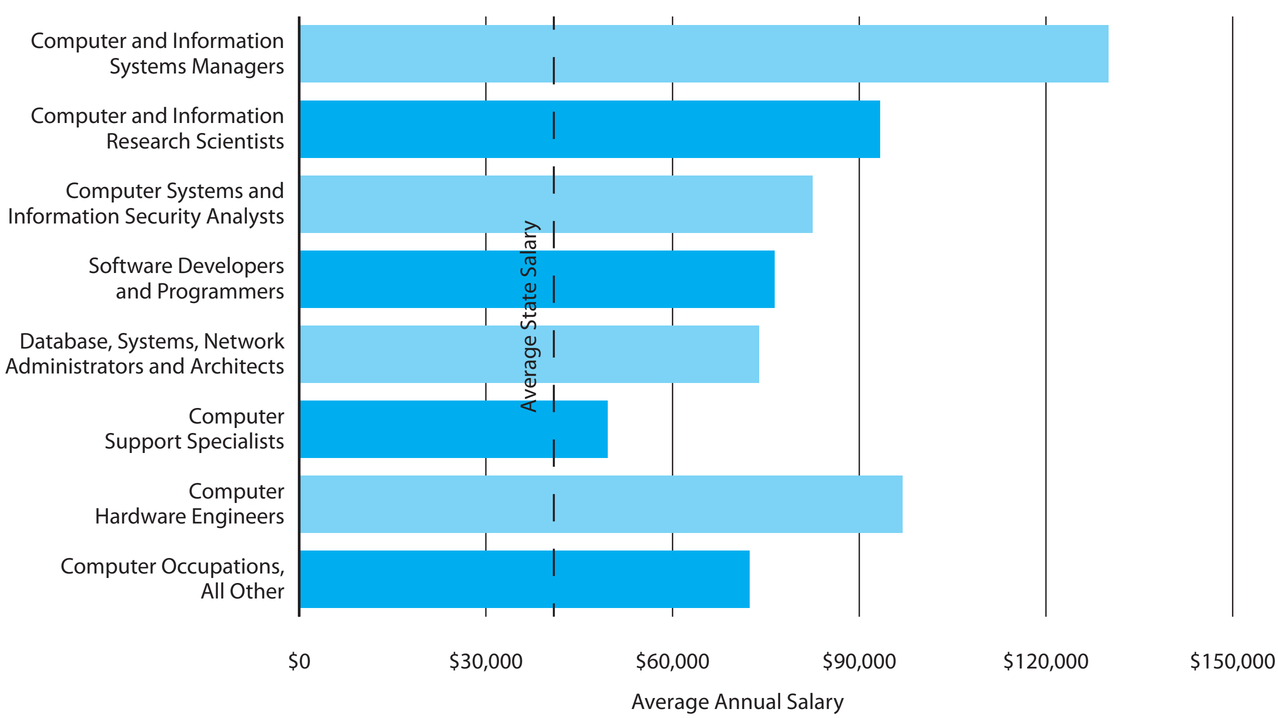


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Florida in 2012



Average Annual Salaries in Computing in Florida in 2012



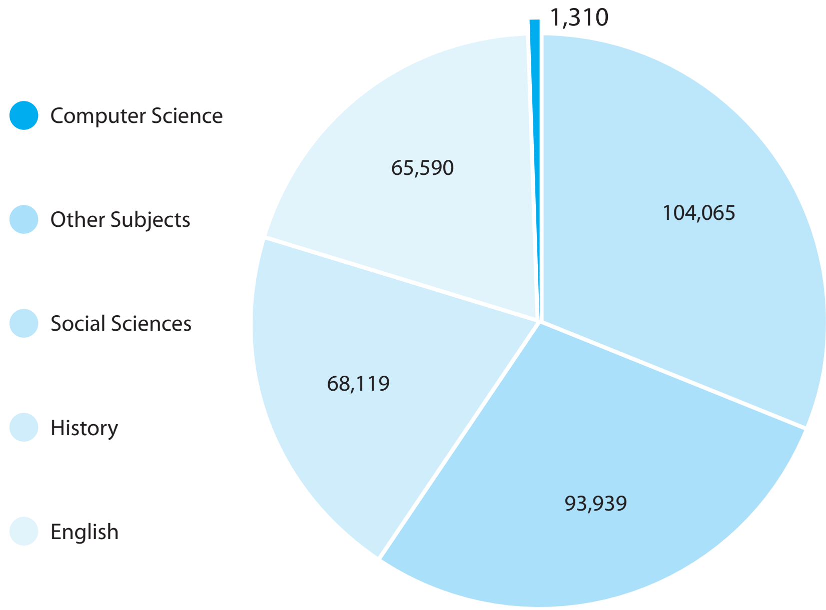
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Florida

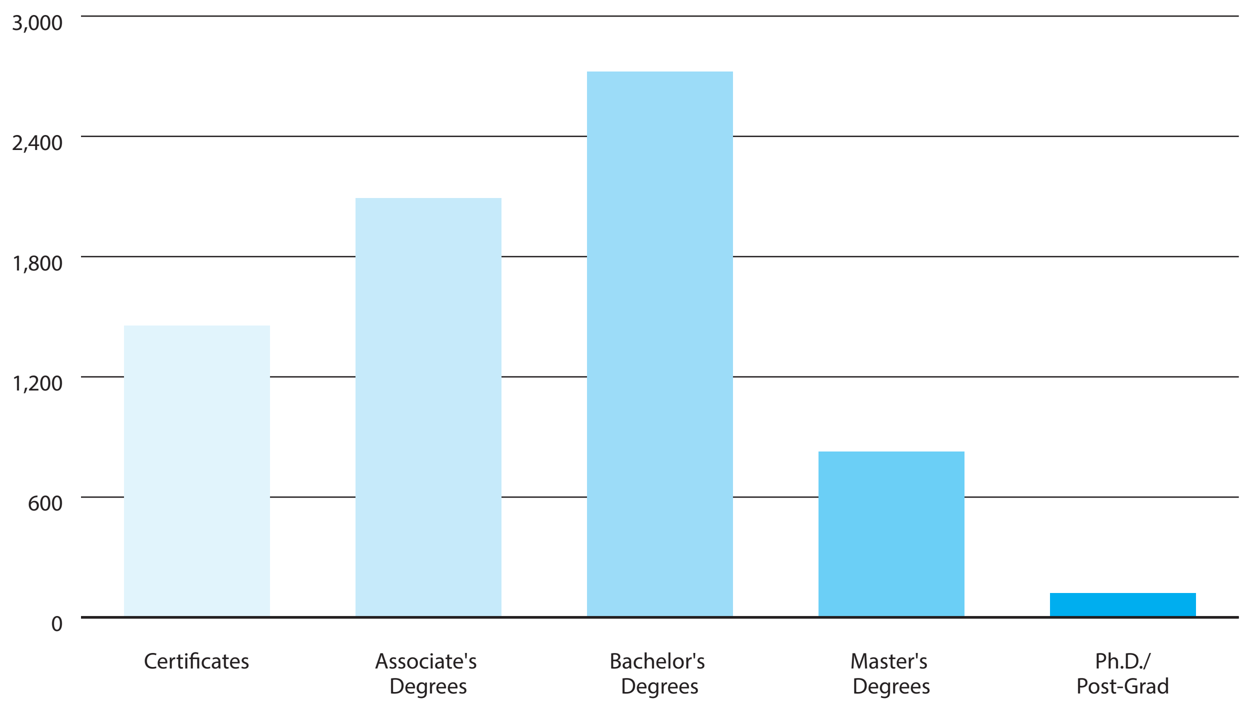
High School Graduation Requirements

Florida does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Florida in 2012

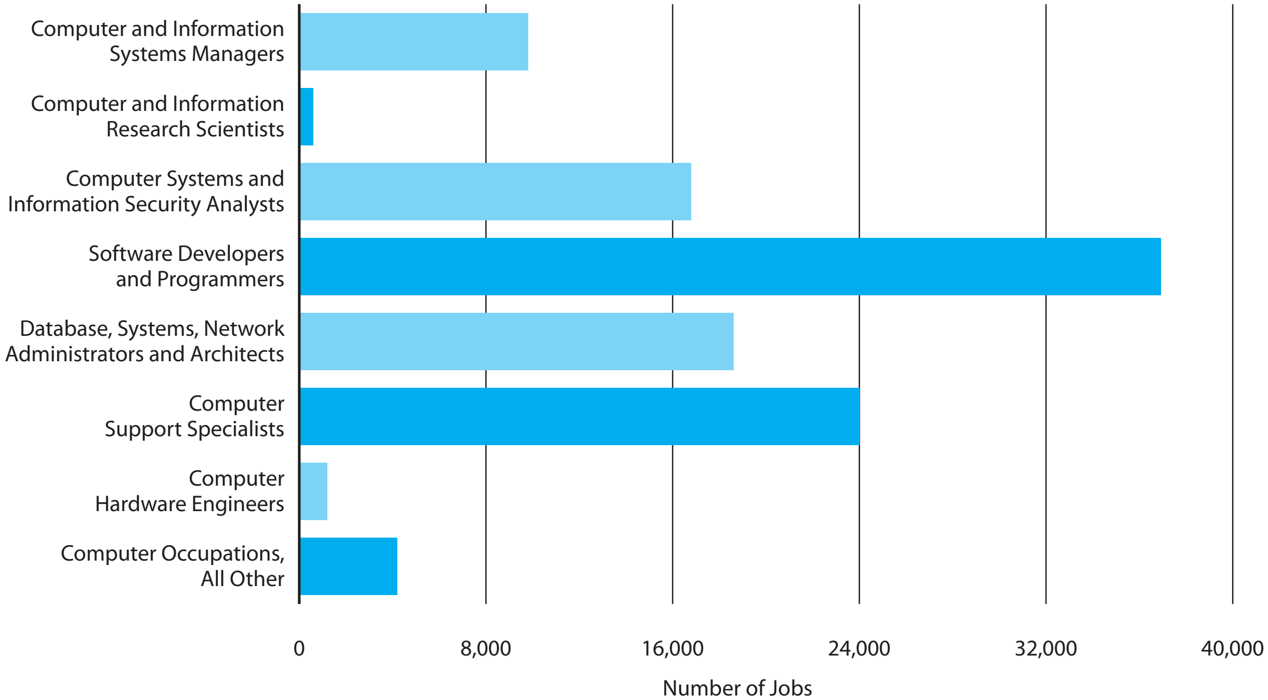


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Florida in 2012

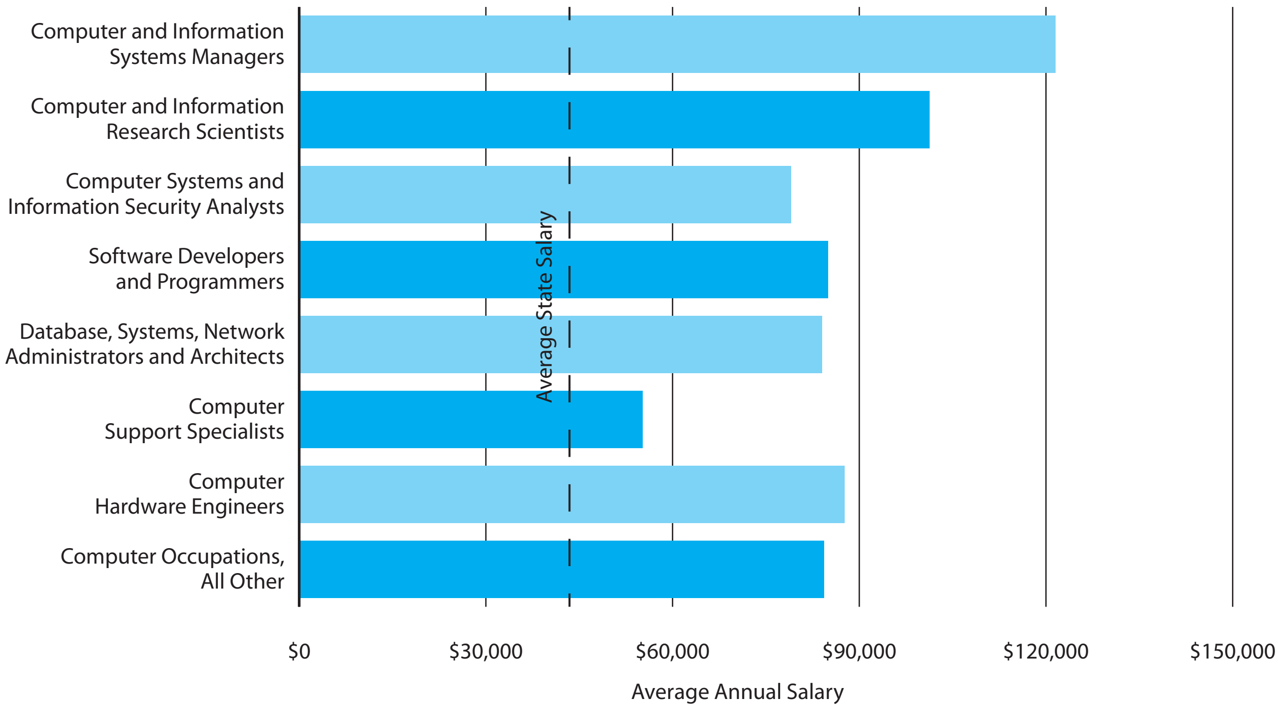


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Georgia in 2012



Average Annual Salaries in Computing in Georgia in 2012



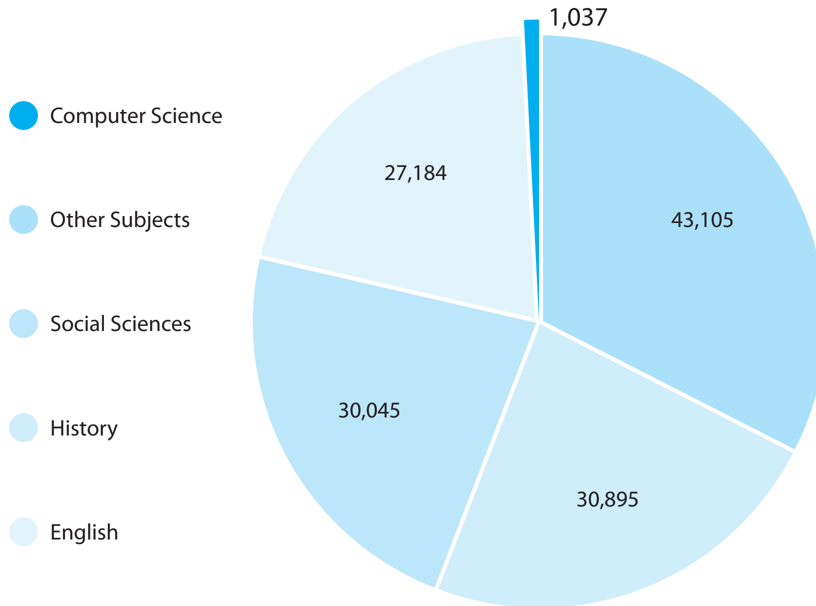
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Georgia

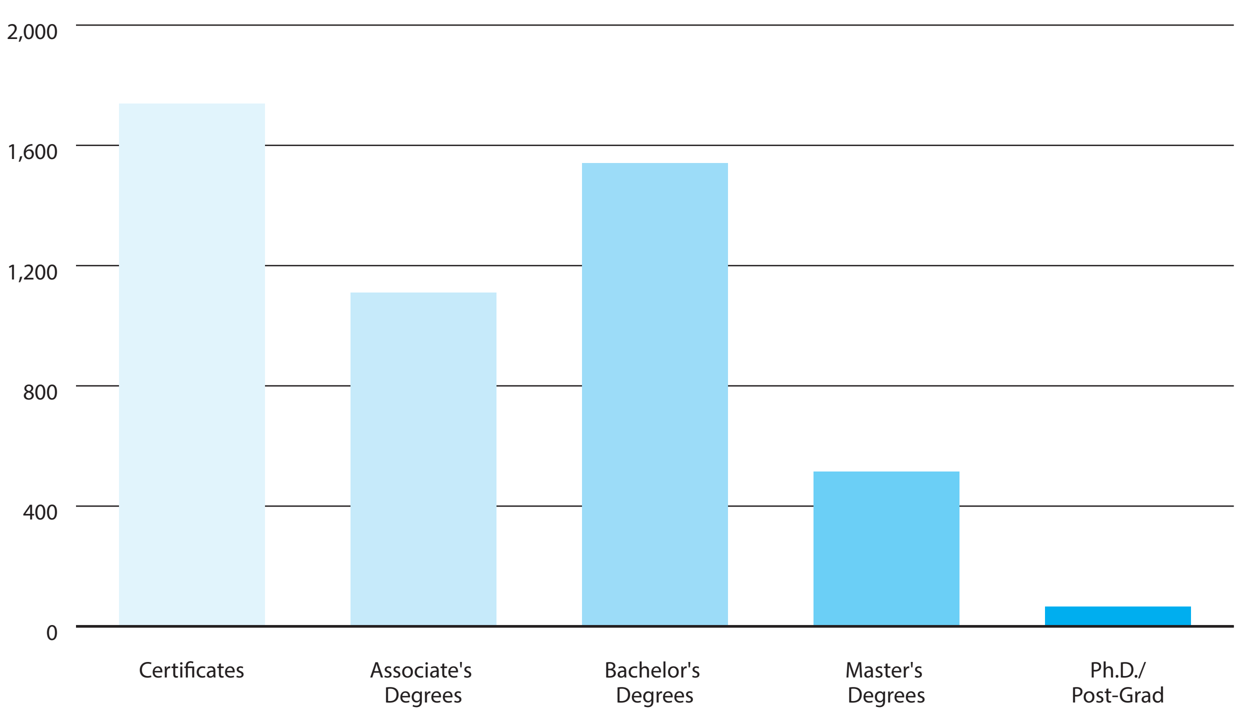
High School Graduation Requirements

Georgia clearly allows computer science to satisfy a core high school graduation requirement in science.

Advanced Placement Exams in Georgia in 2012

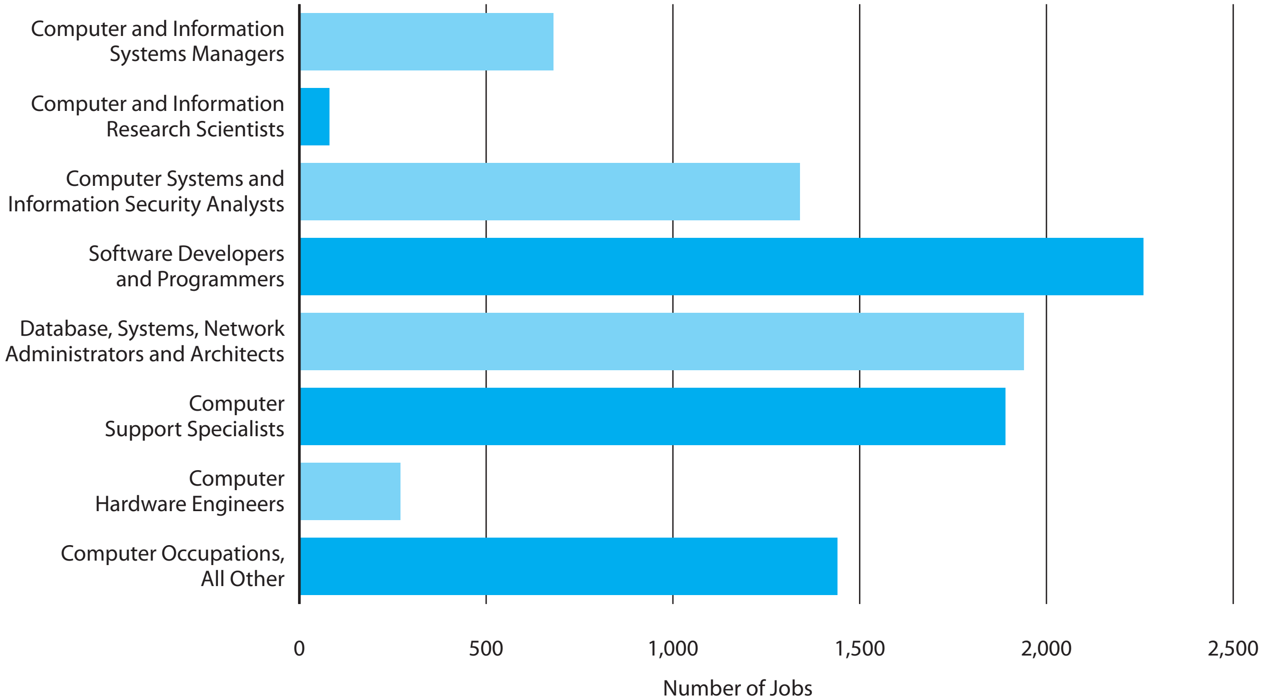


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Georgia in 2012

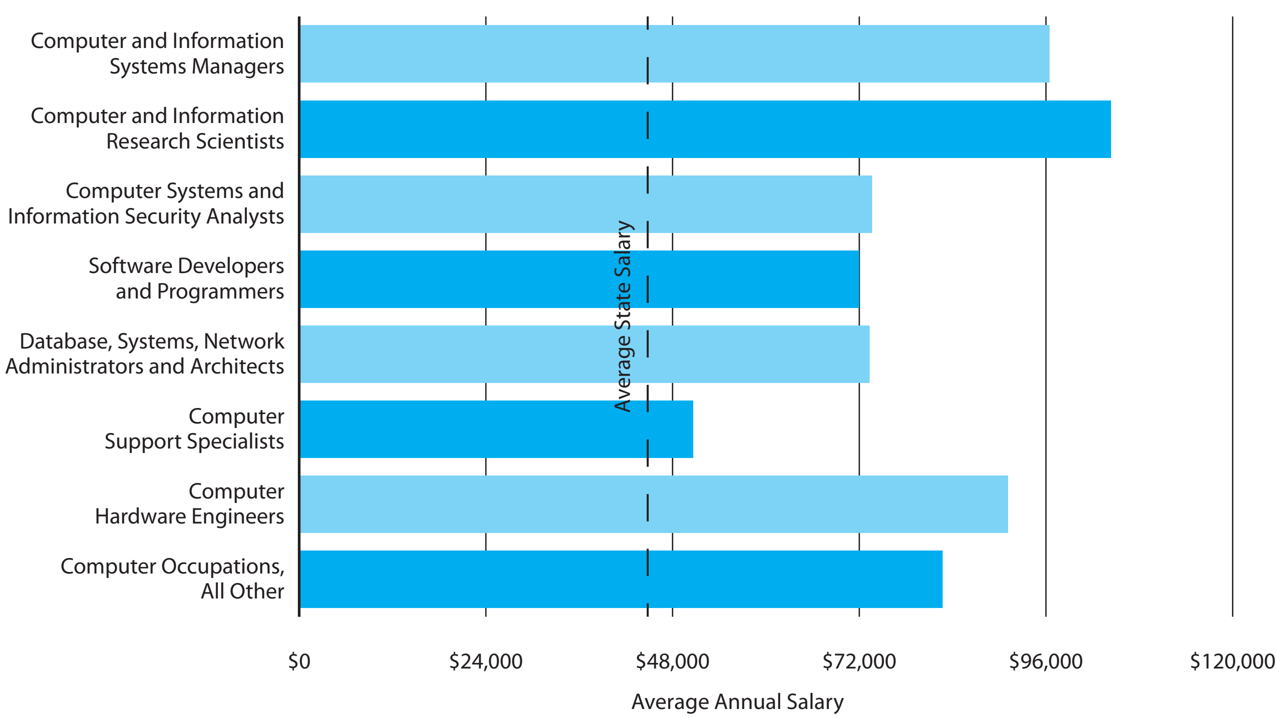


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Hawaii in 2012



Average Annual Salaries in Computing in Hawaii in 2012



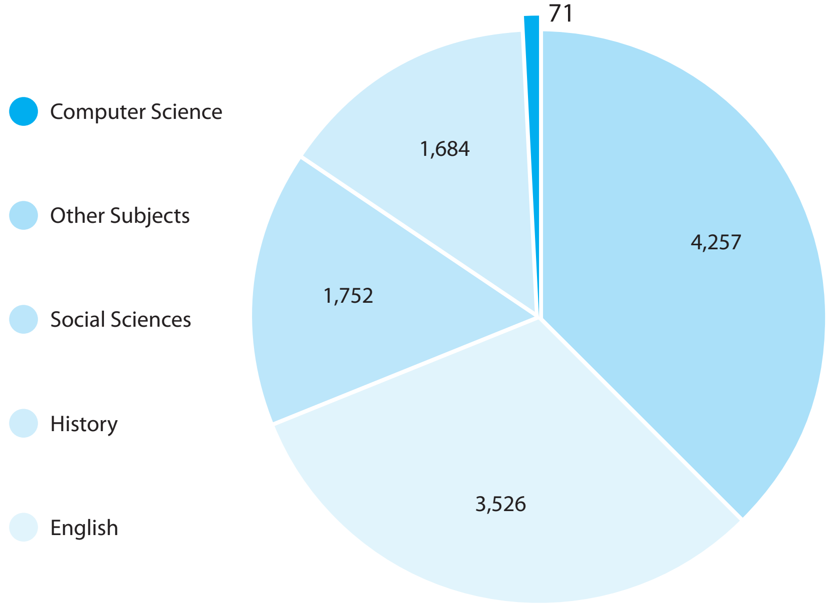
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Hawaii

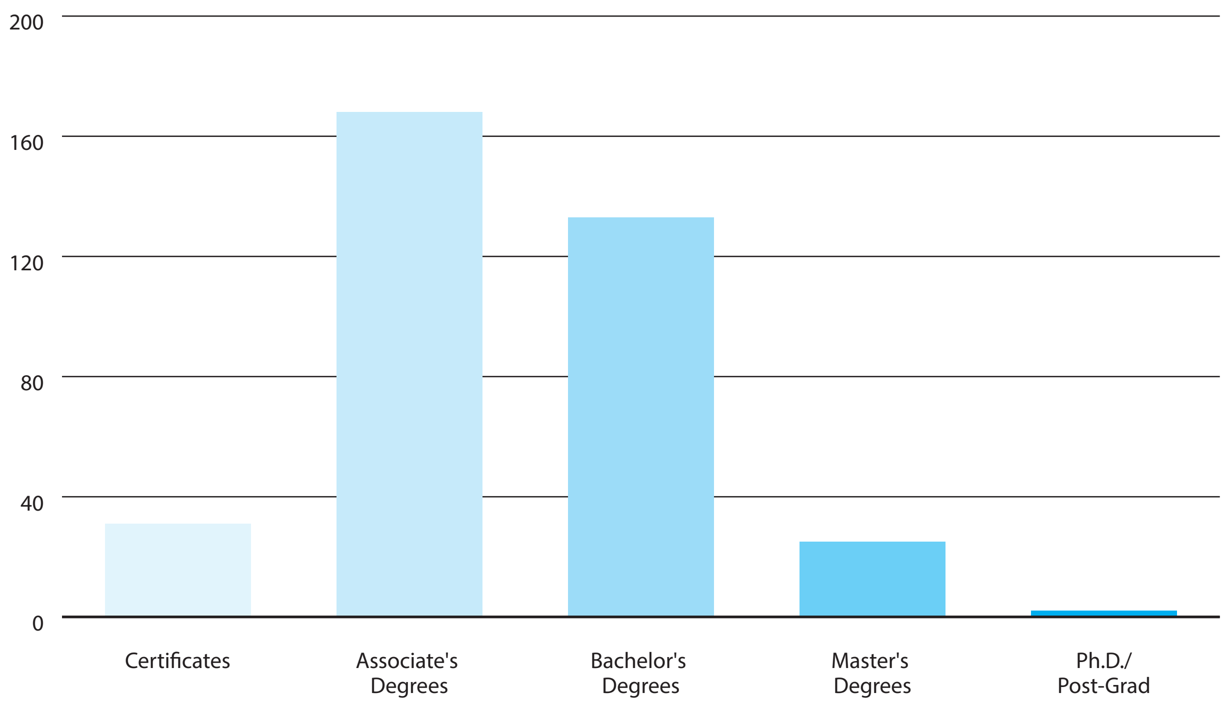
High School Graduation Requirements

Hawaii does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

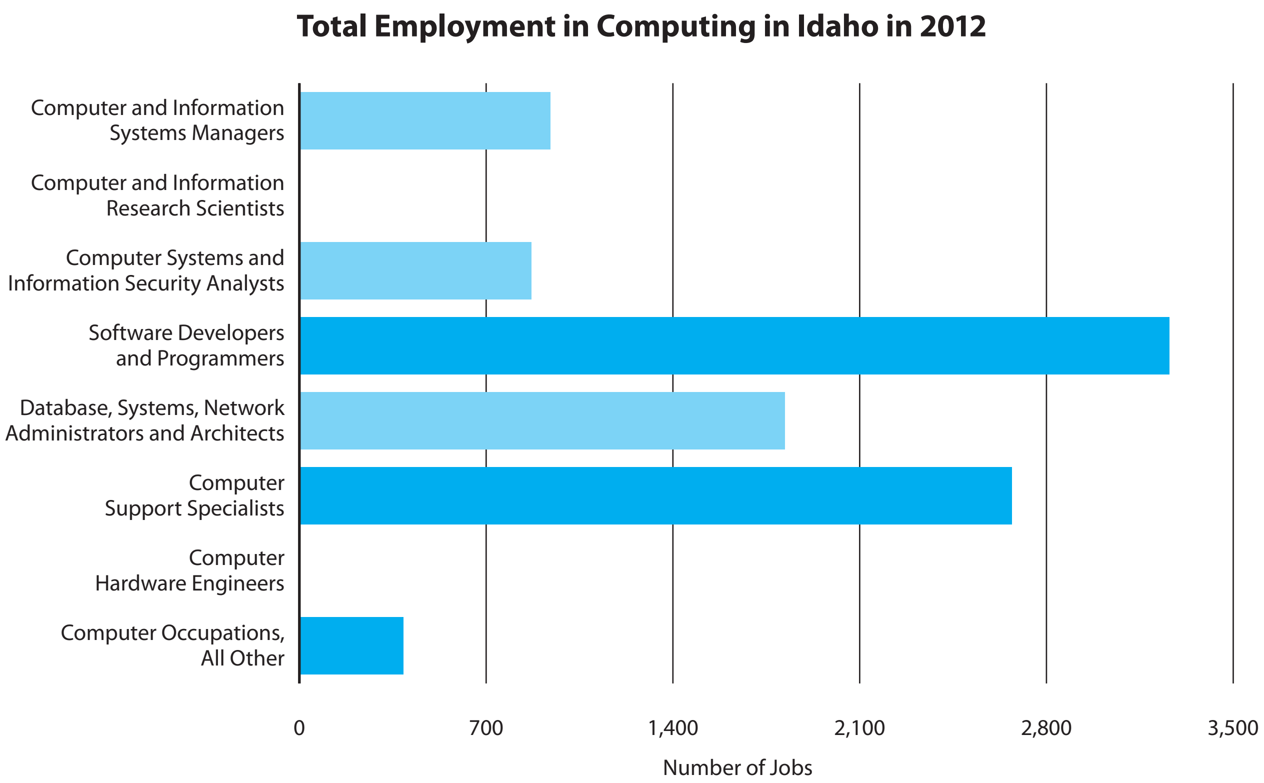
Advanced Placement Exams in Hawaii in 2012

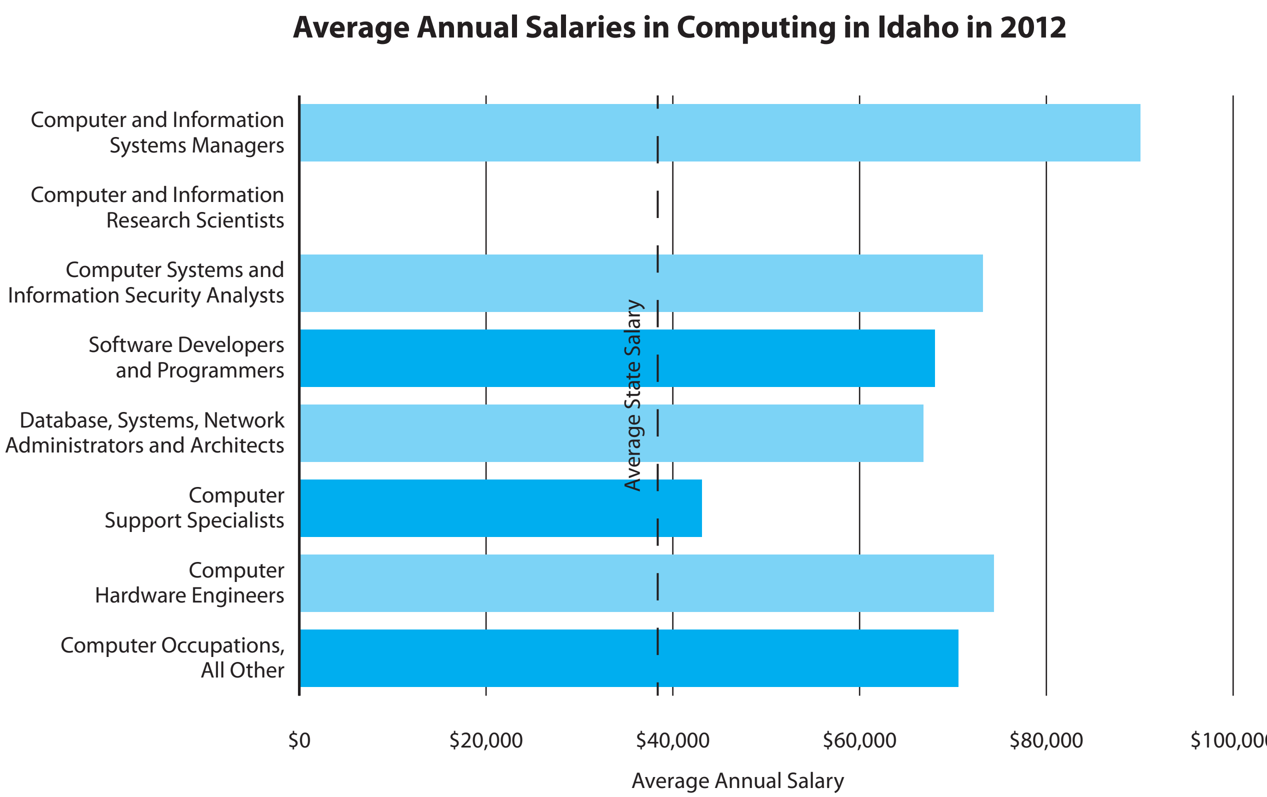


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Hawaii in 2012



Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).





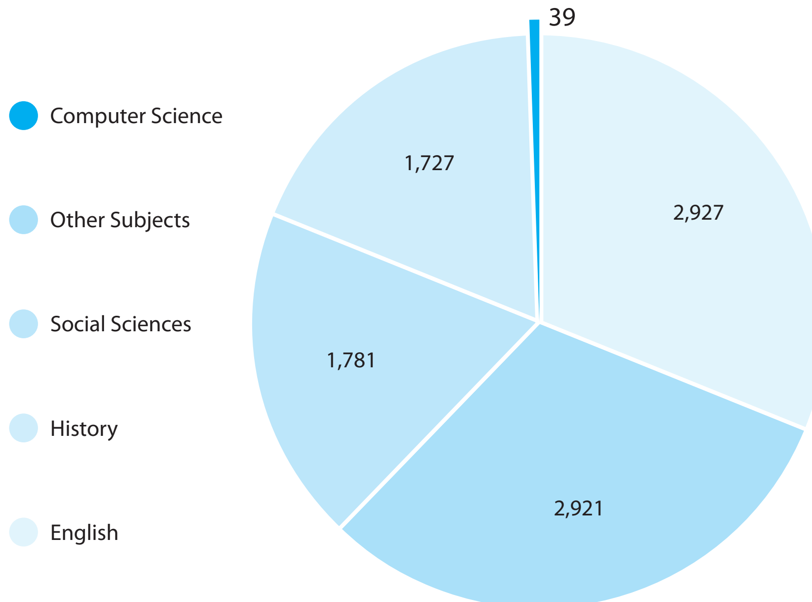
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Idaho

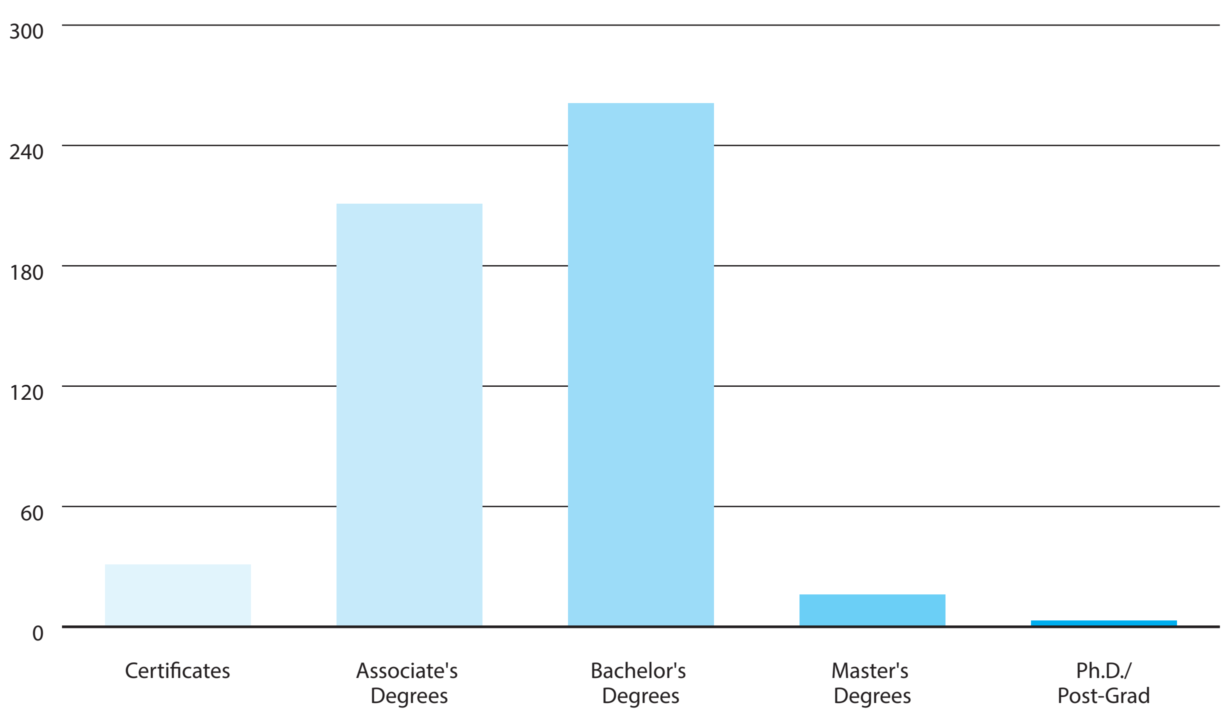
High School Graduation Requirements

Idaho does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Idaho in 2012

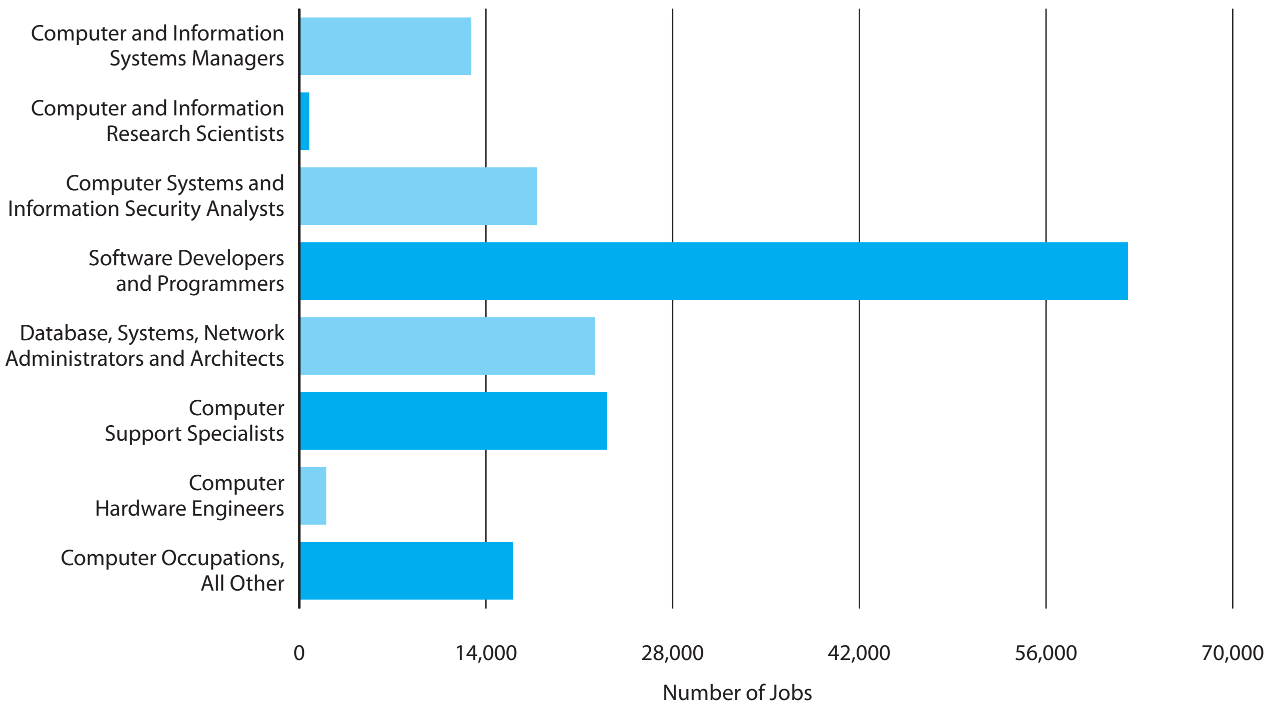


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Idaho in 2012

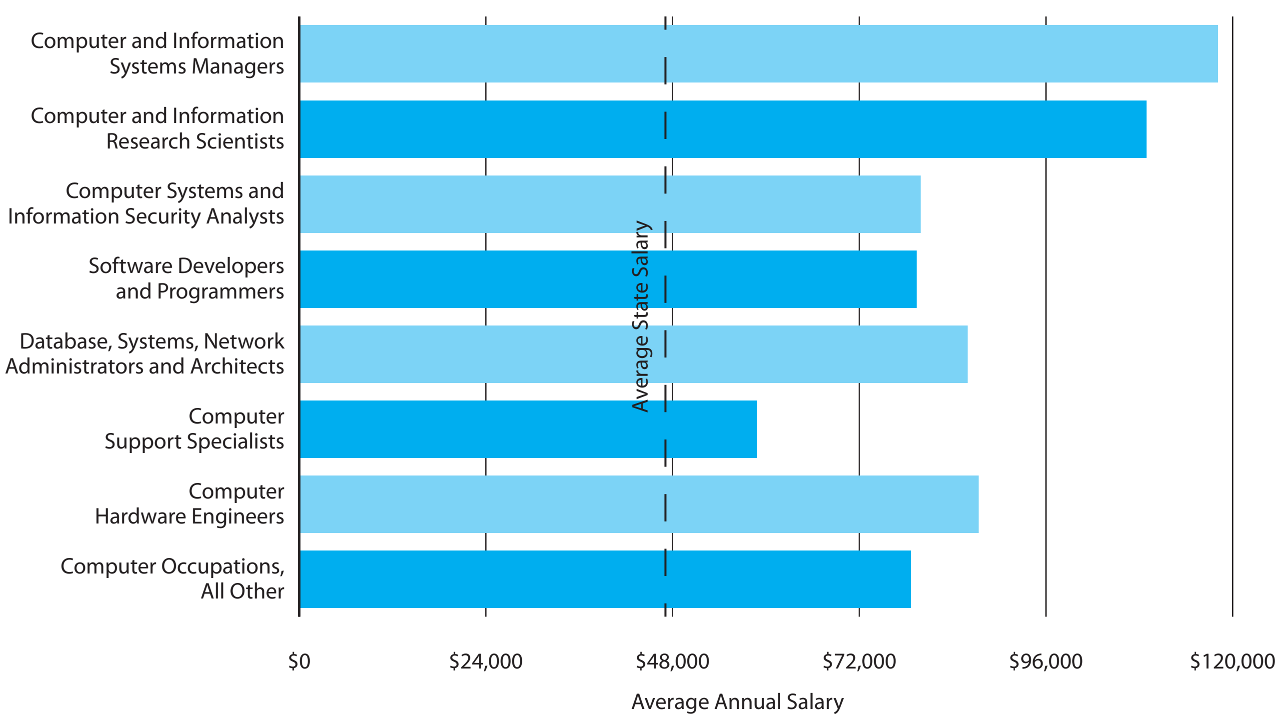


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Illinois in 2012



Average Annual Salaries in Computing in Illinois in 2012



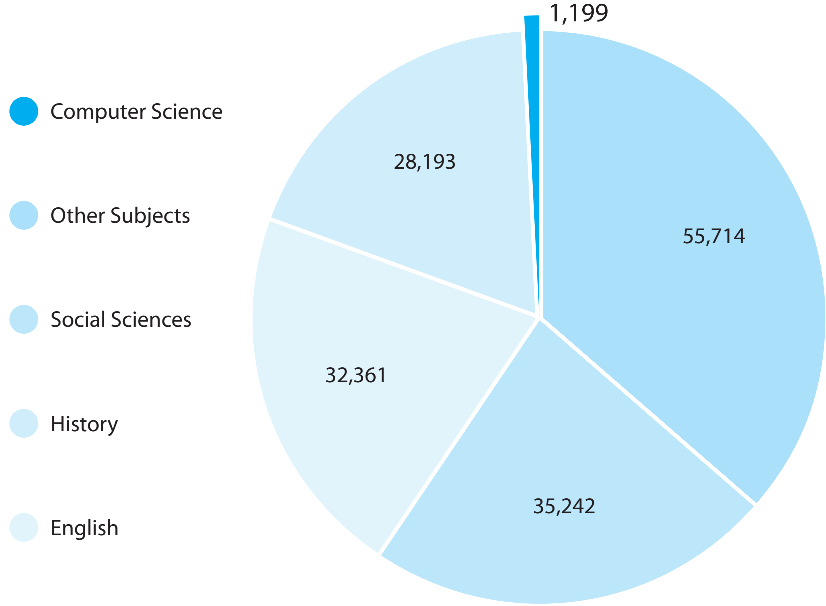
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Illinois

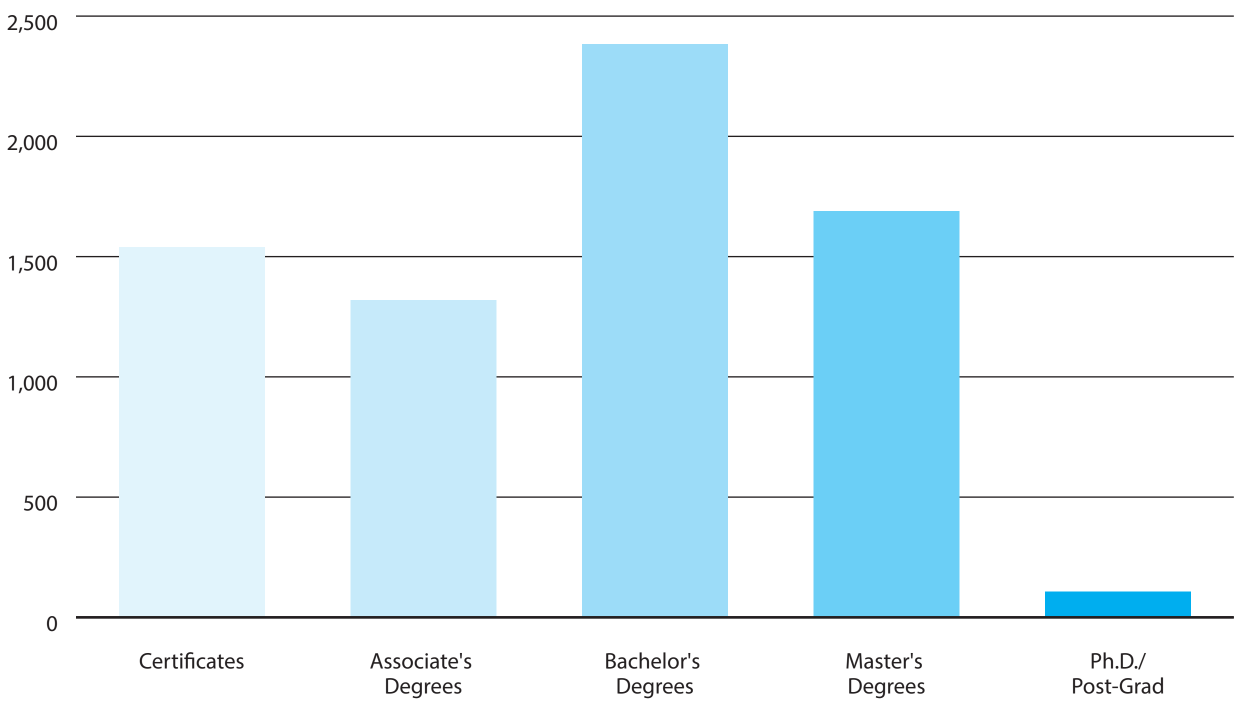
High School Graduation Requirements

Illinois does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Illinois in 2012

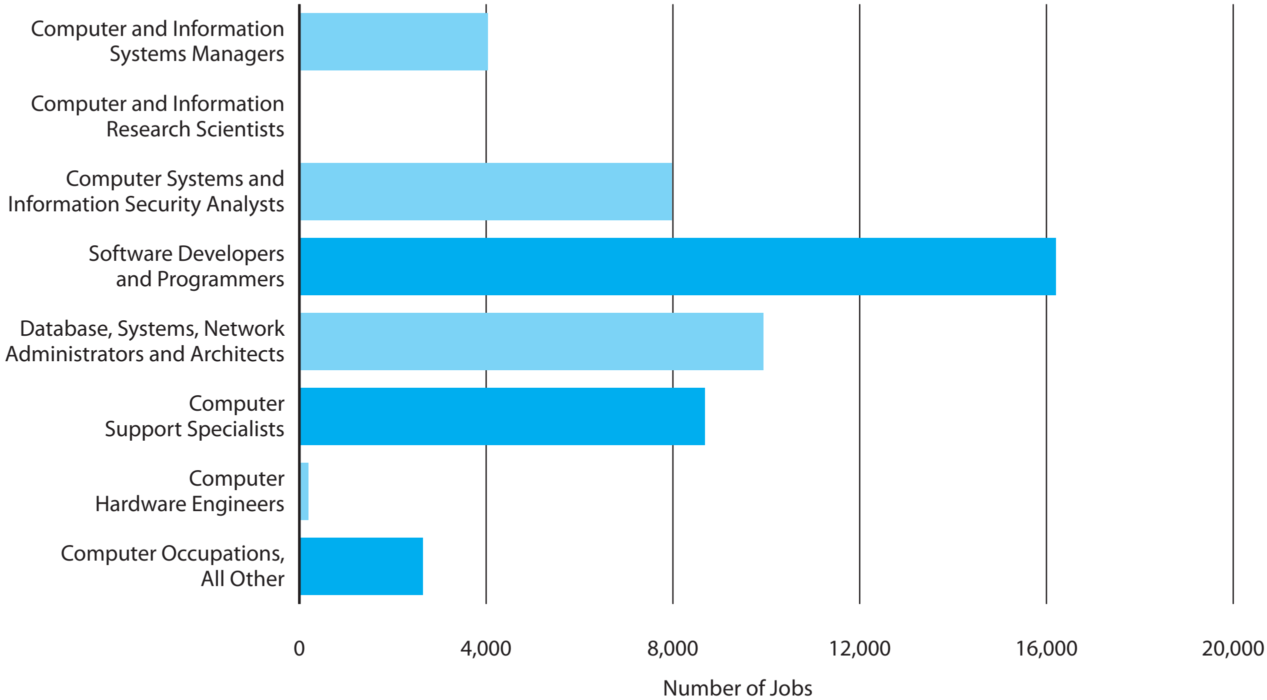


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Illinois in 2012

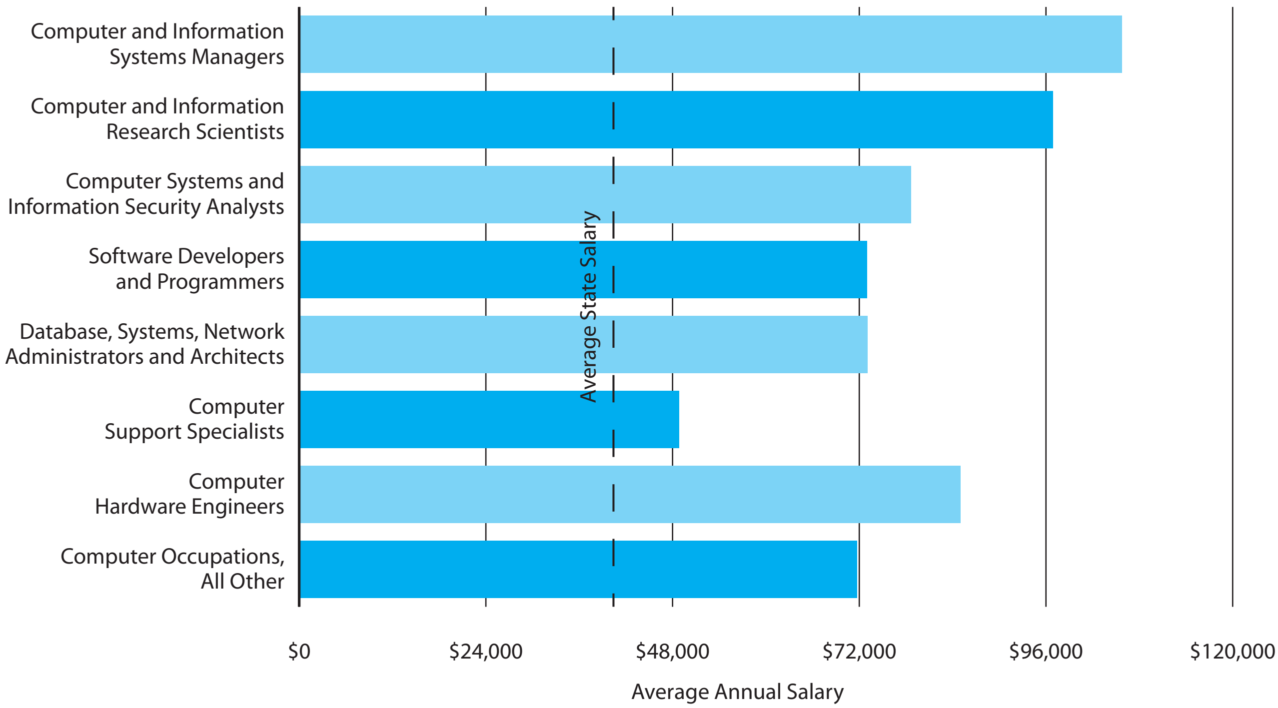


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Indiana in 2012



Average Annual Salaries in Computing in Indiana in 2012



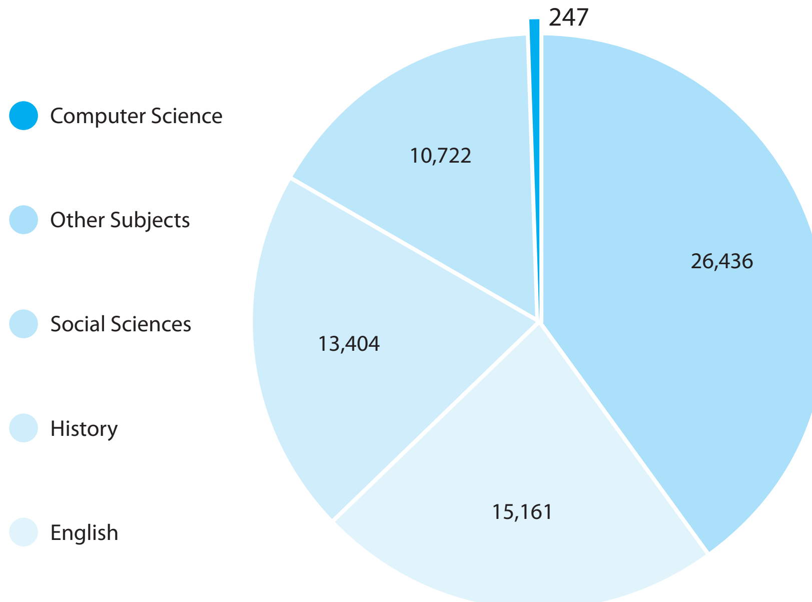
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Indiana

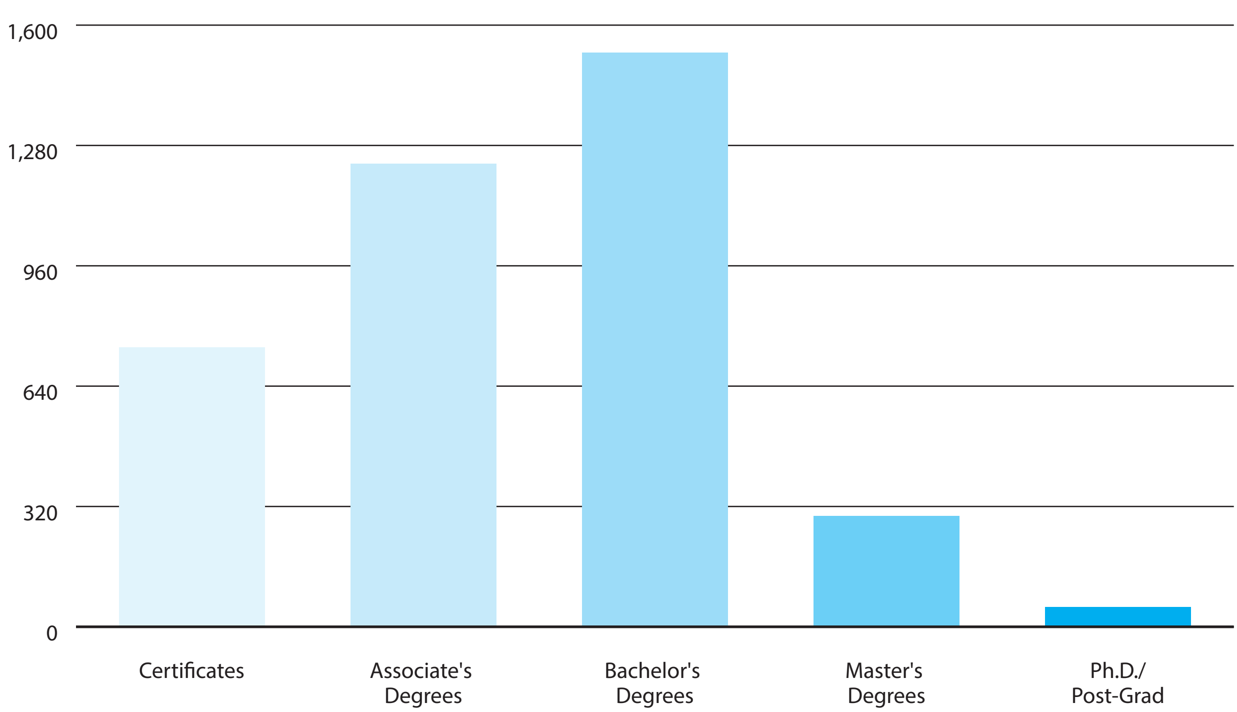
High School Graduation Requirements

Indiana clearly allows computer science to satisfy a core high school graduation requirement in mathematics.

Advanced Placement Exams in Indiana in 2012

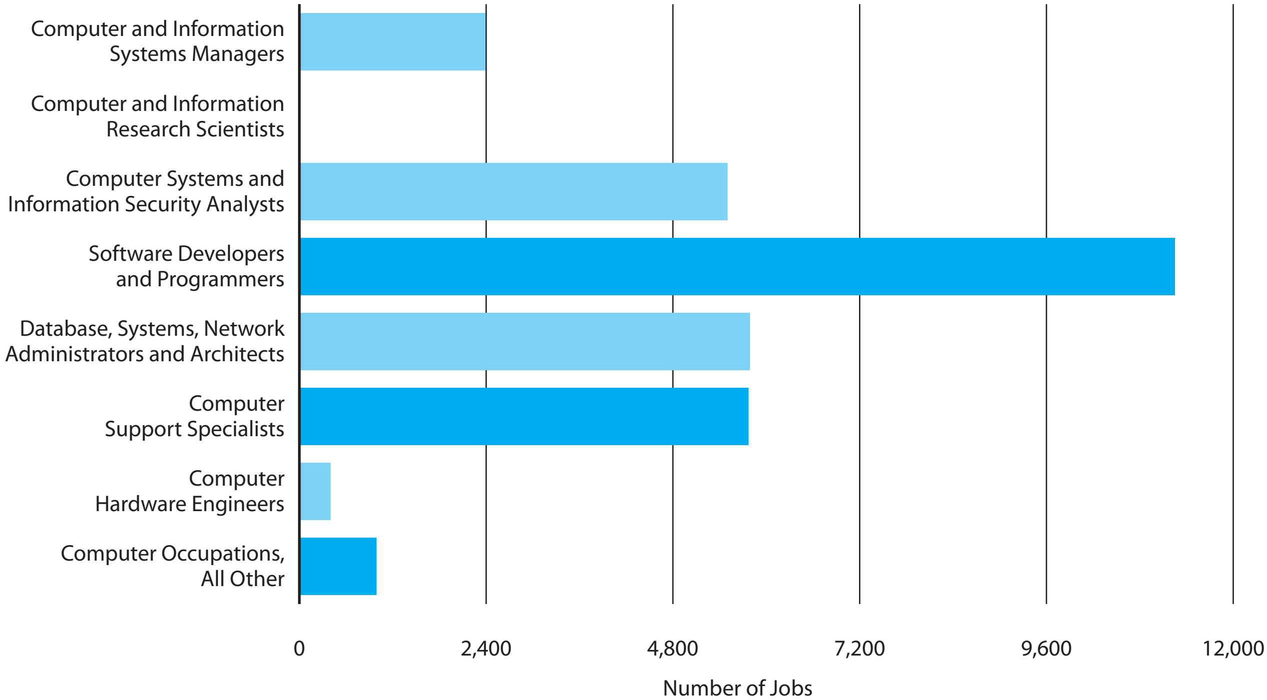


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Indiana in 2012

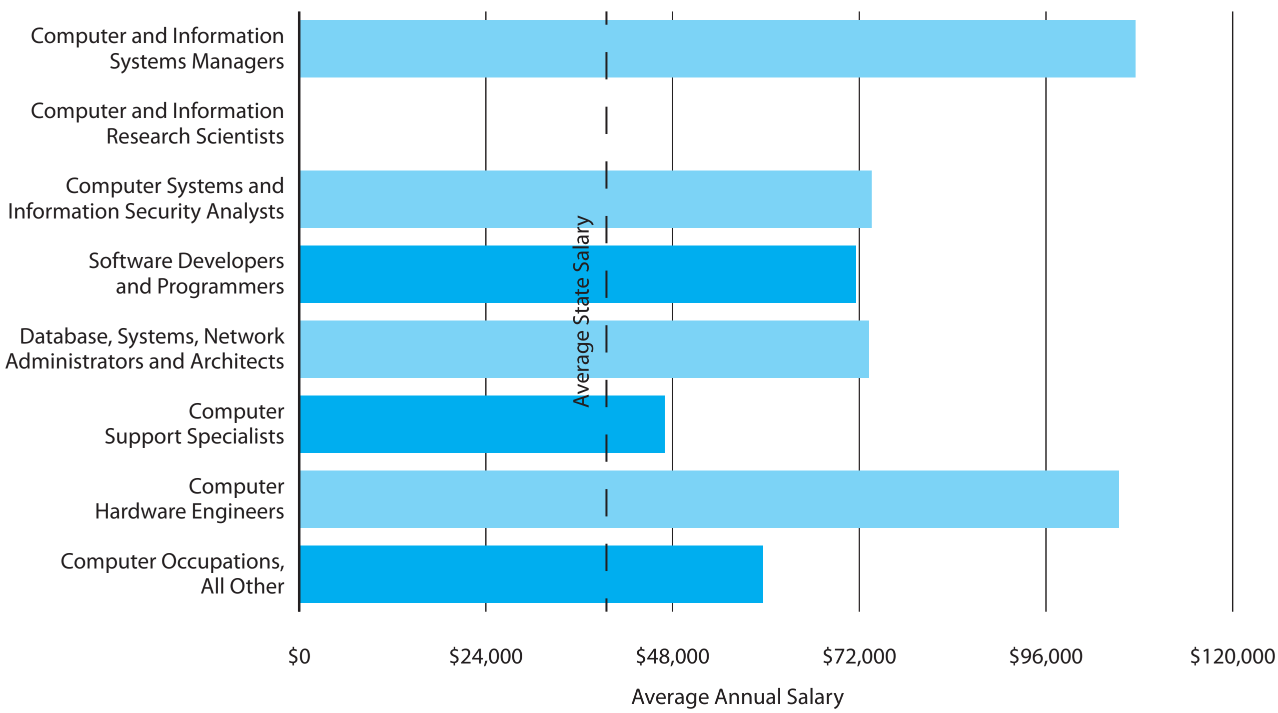


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Iowa in 2012



Average Annual Salaries in Computing in Iowa in 2012



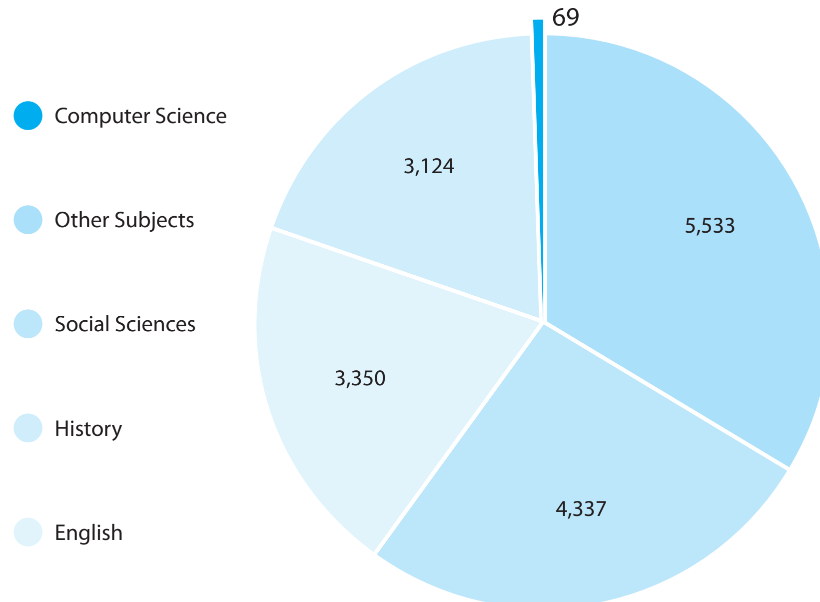
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Iowa

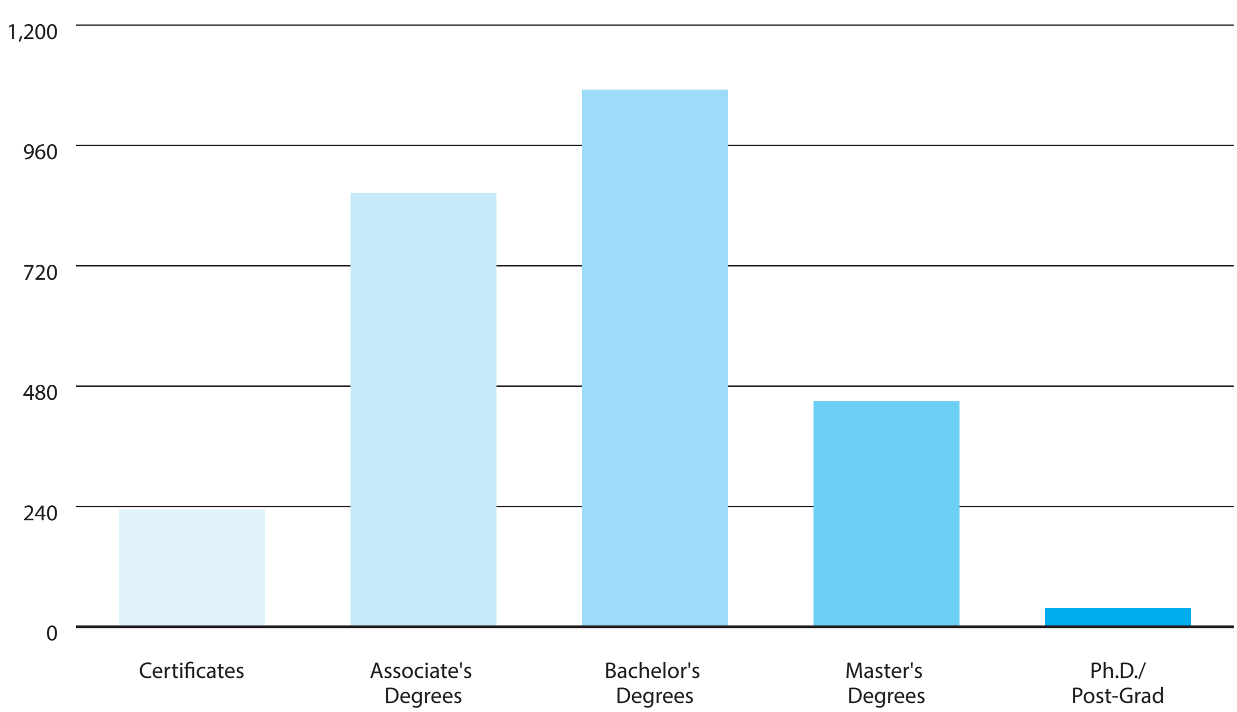
High School Graduation Requirements

Iowa does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Iowa in 2012

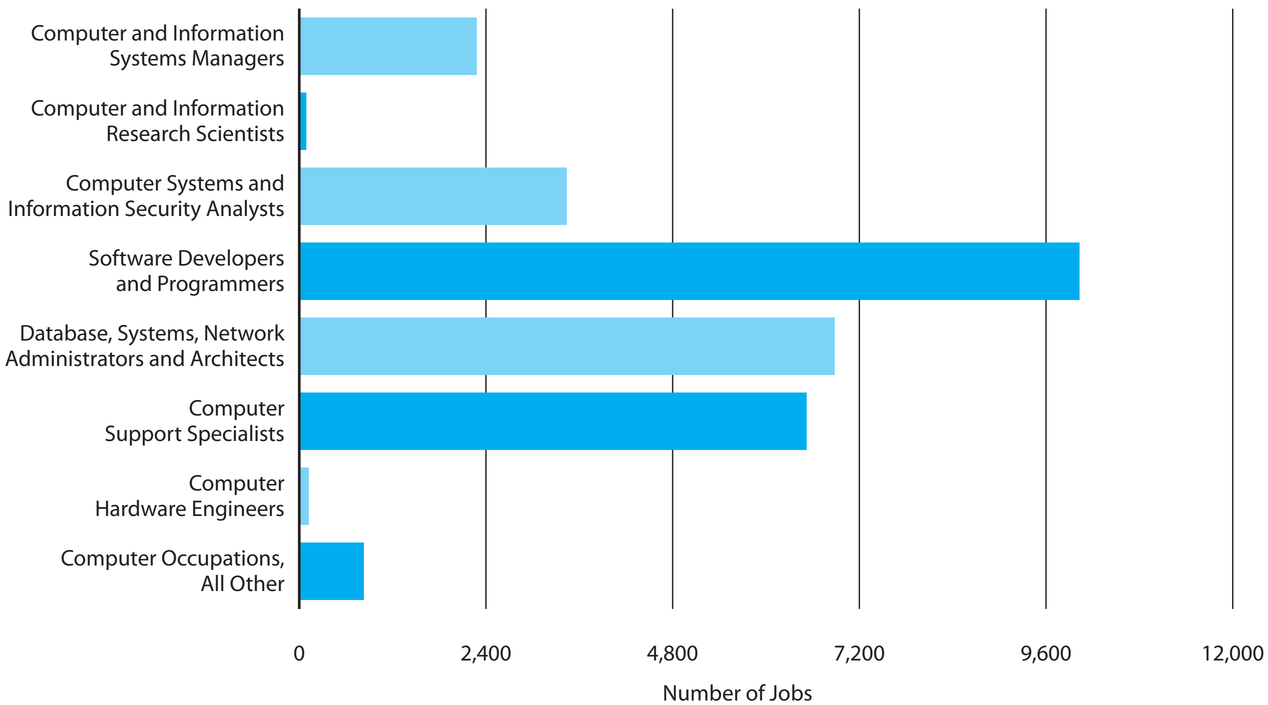


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Iowa in 2012

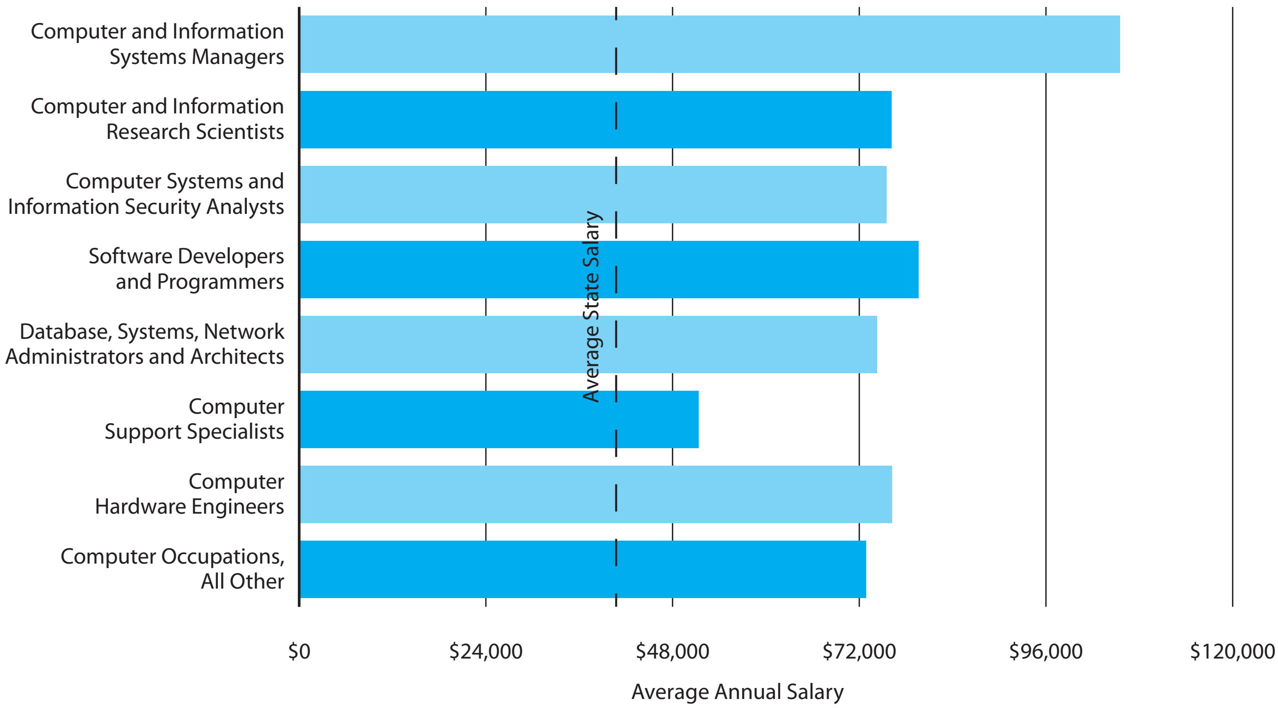


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Kansas in 2012



Average Annual Salaries in Computing in Kansas in 2012



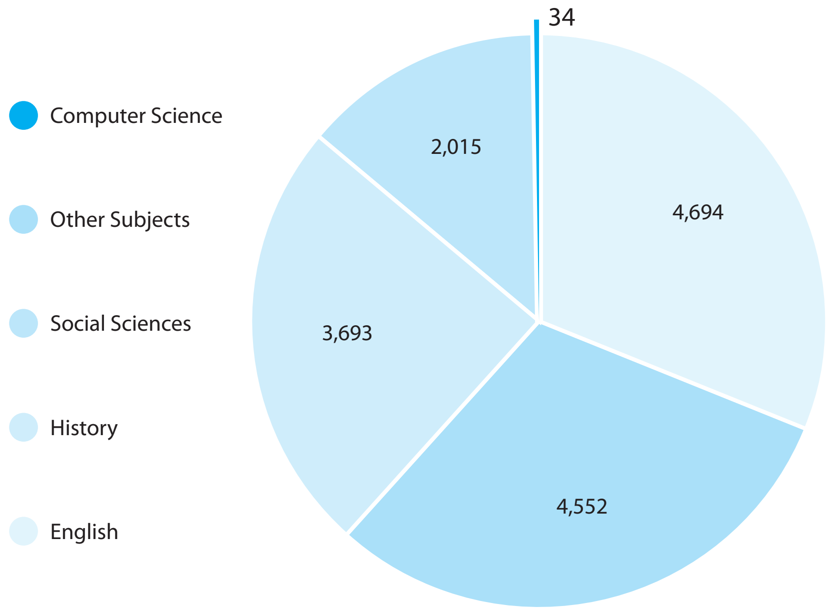
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Kansas

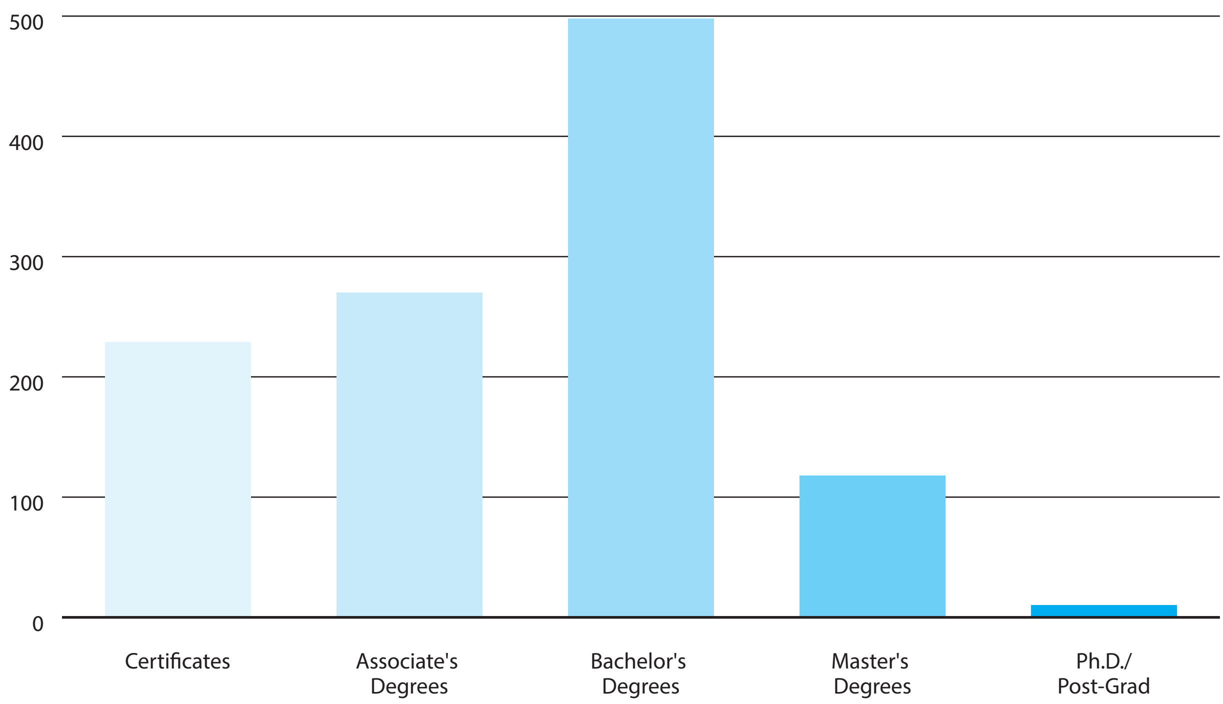
High School Graduation Requirements

Kansas does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Kansas in 2012

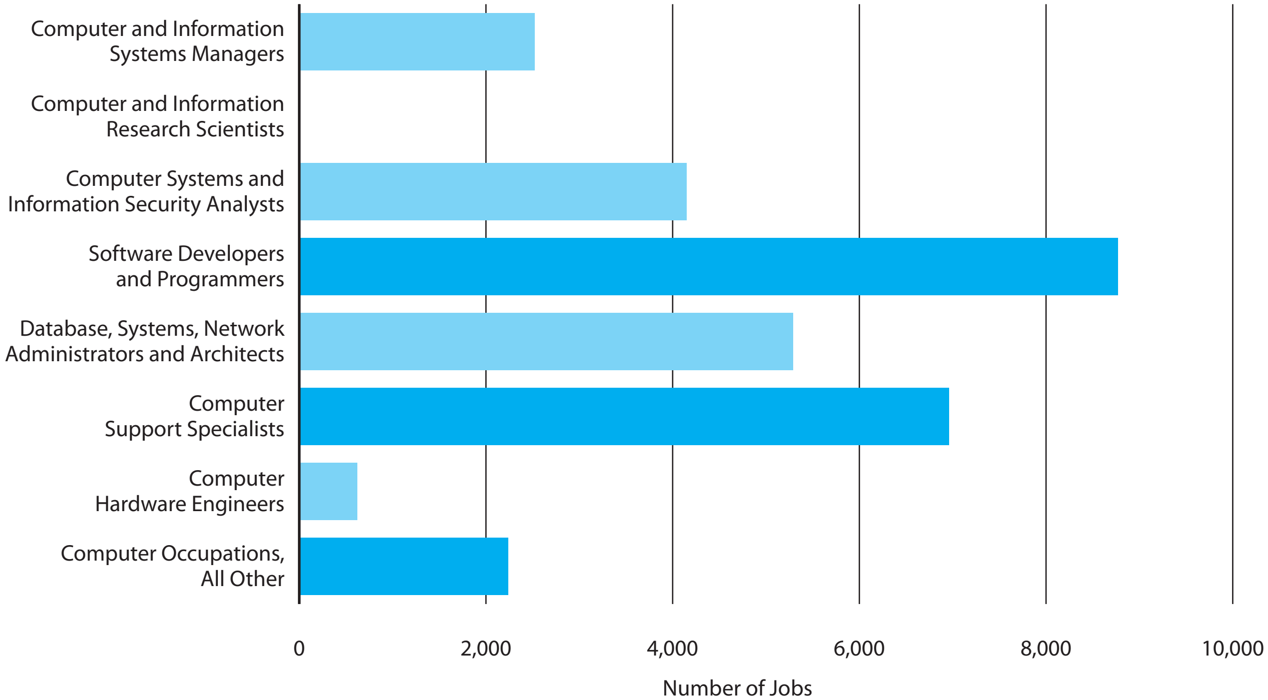


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Kansas in 2012

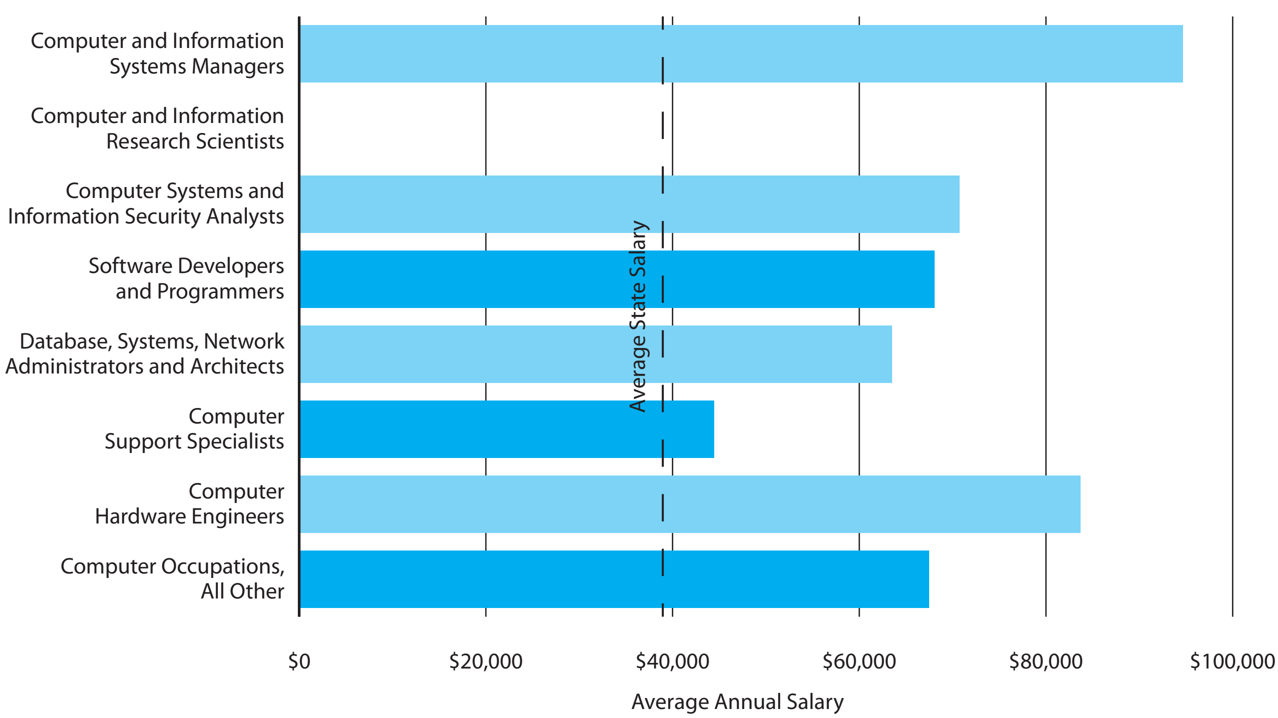


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Kentucky in 2012



Average Annual Salaries in Computing in Kentucky in 2012



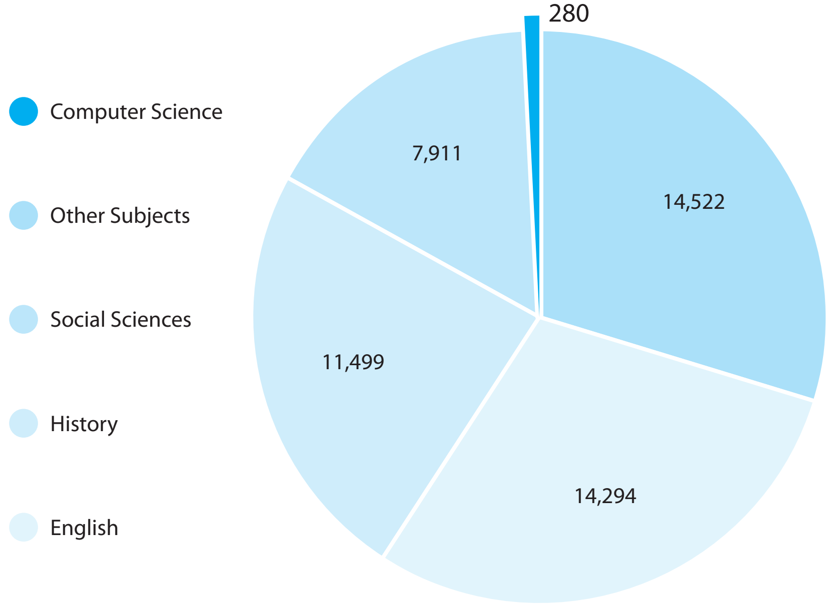
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Kentucky

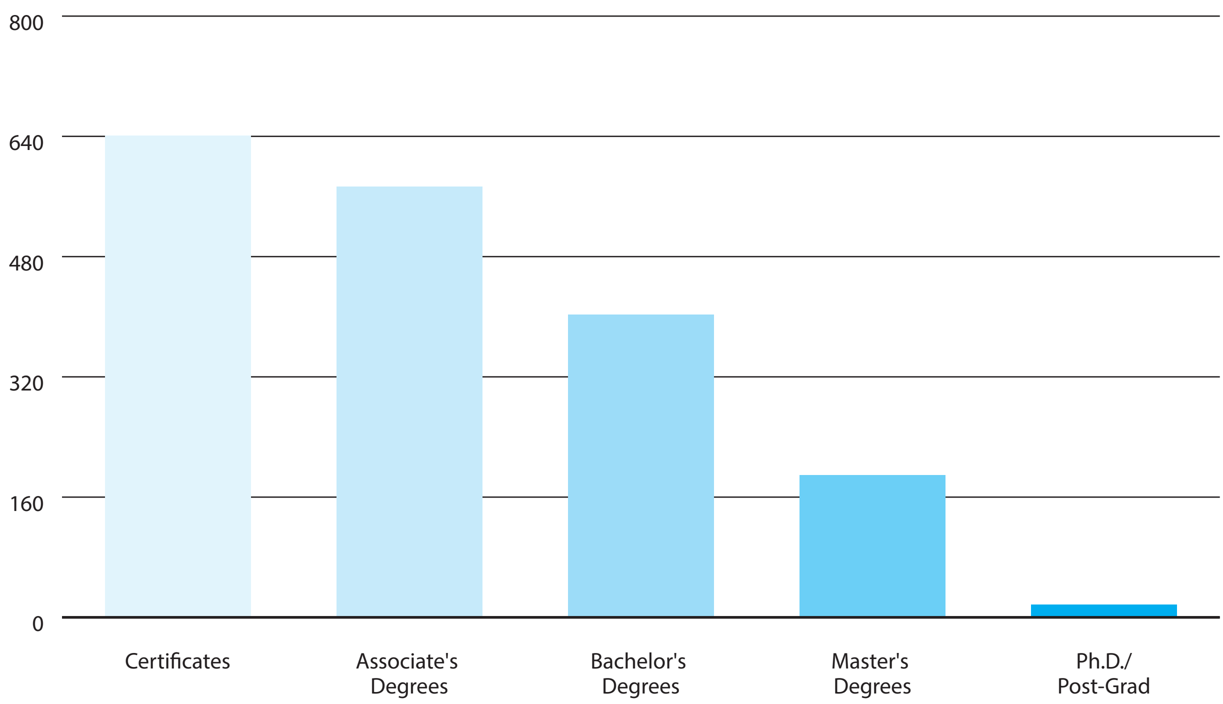
High School Graduation Requirements

Kentucky does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Kentucky in 2012

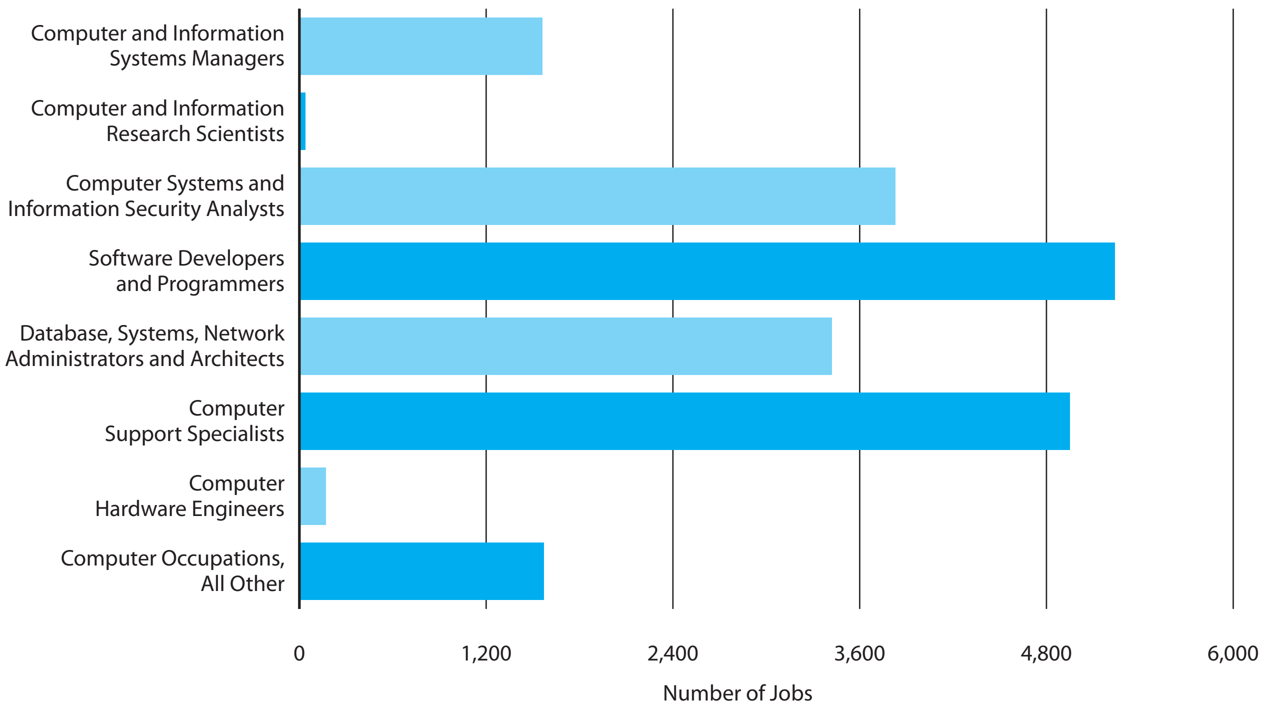


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Kentucky in 2012

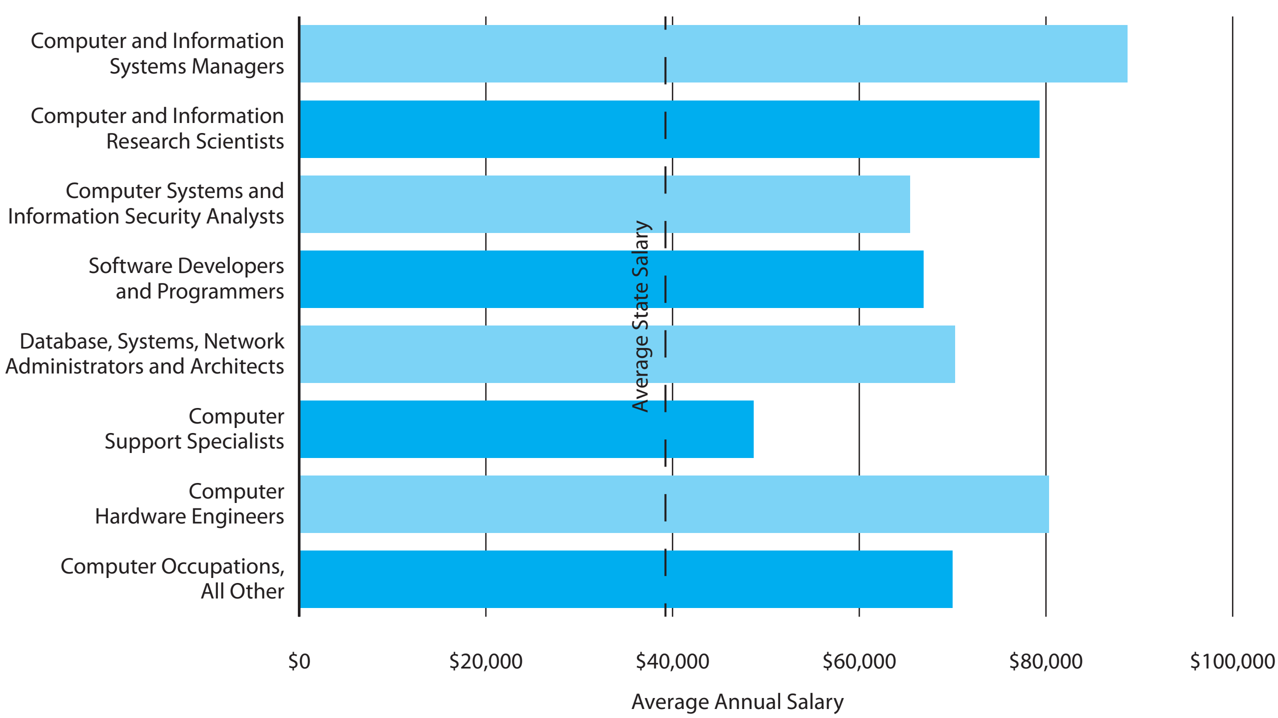


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Louisiana in 2012



Average Annual Salaries in Computing in Louisiana in 2012



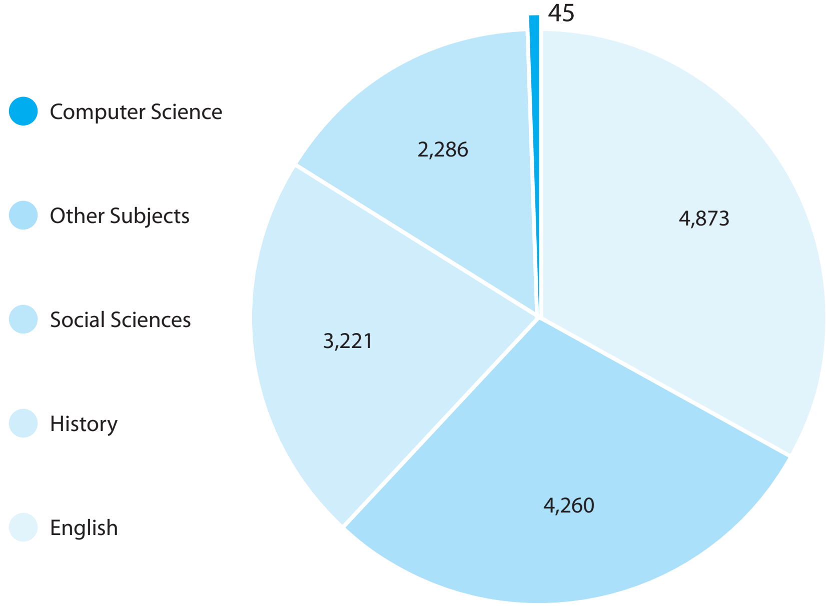
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Louisiana

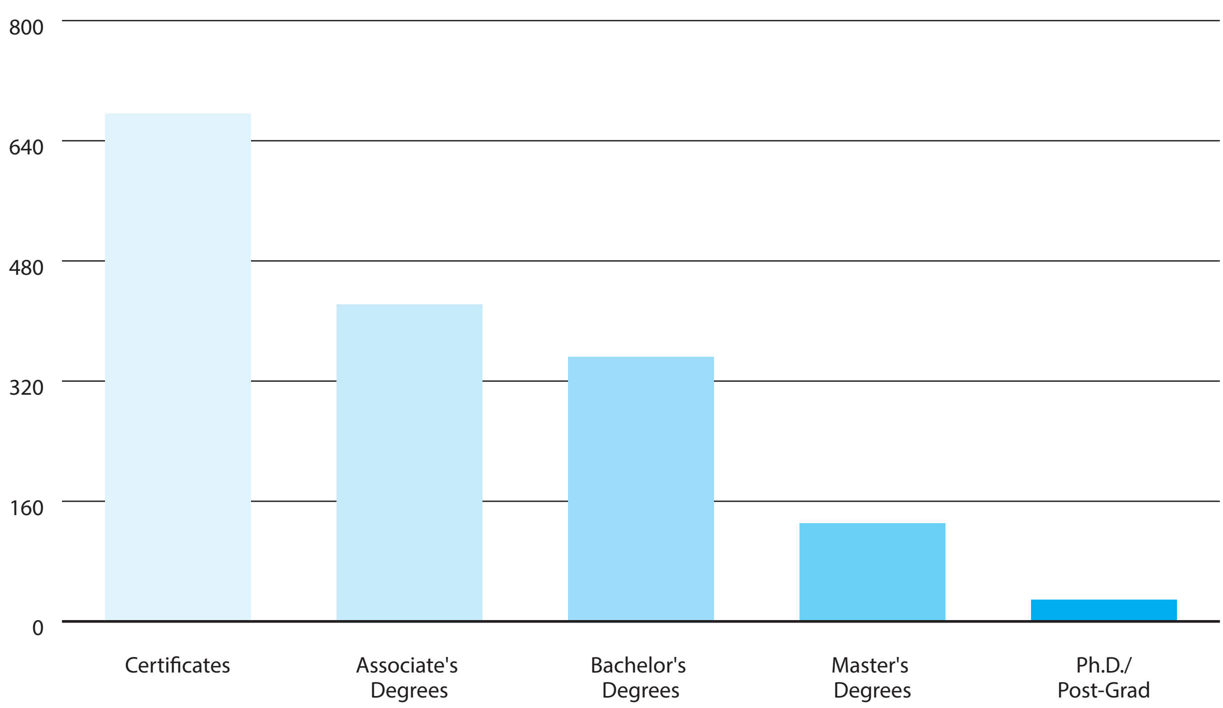
High School Graduation Requirements

Louisiana does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

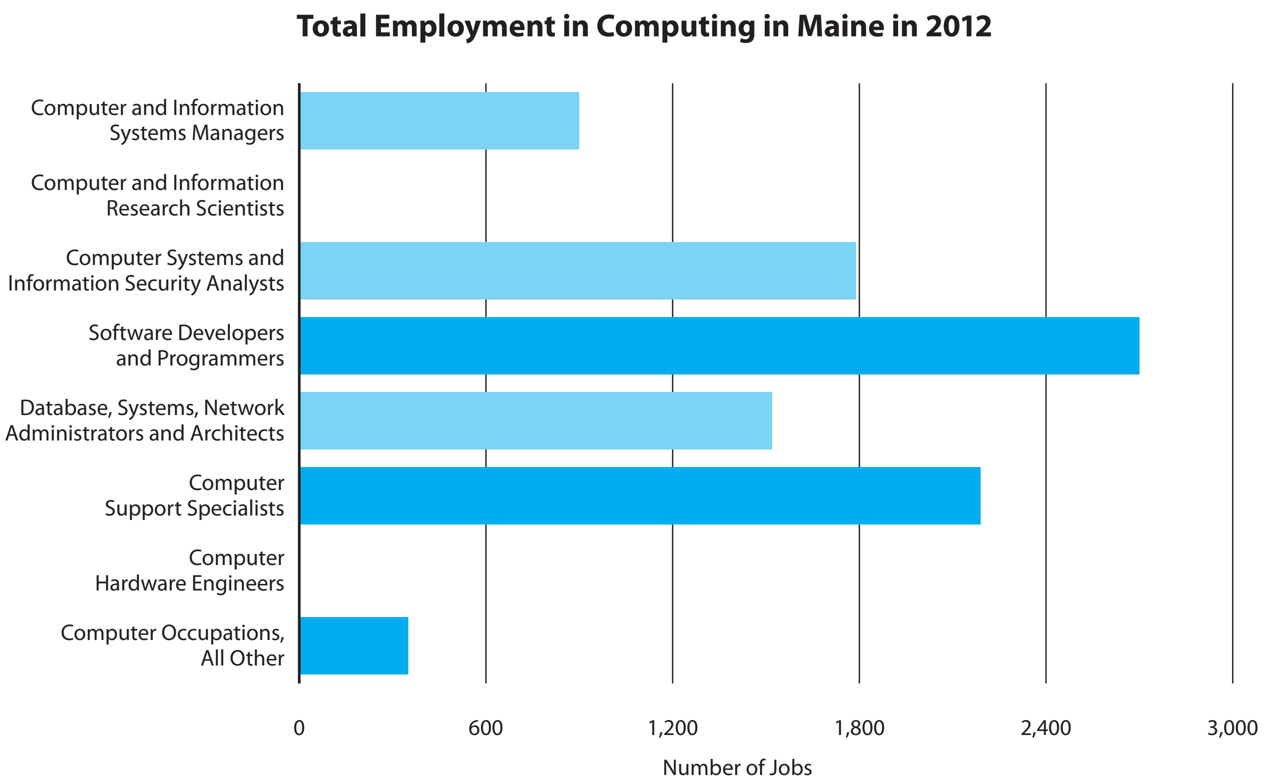
Advanced Placement Exams in Louisiana in 2012

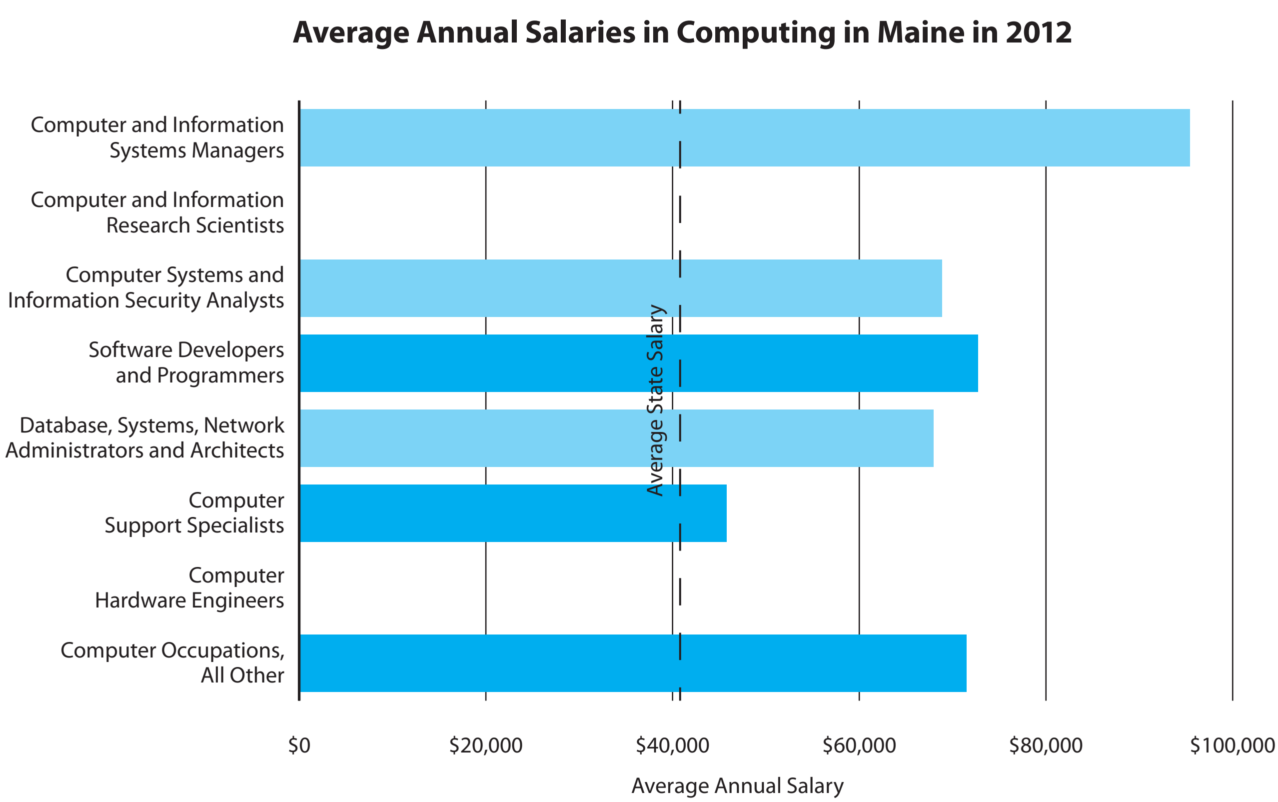


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Louisiana in 2012



Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).





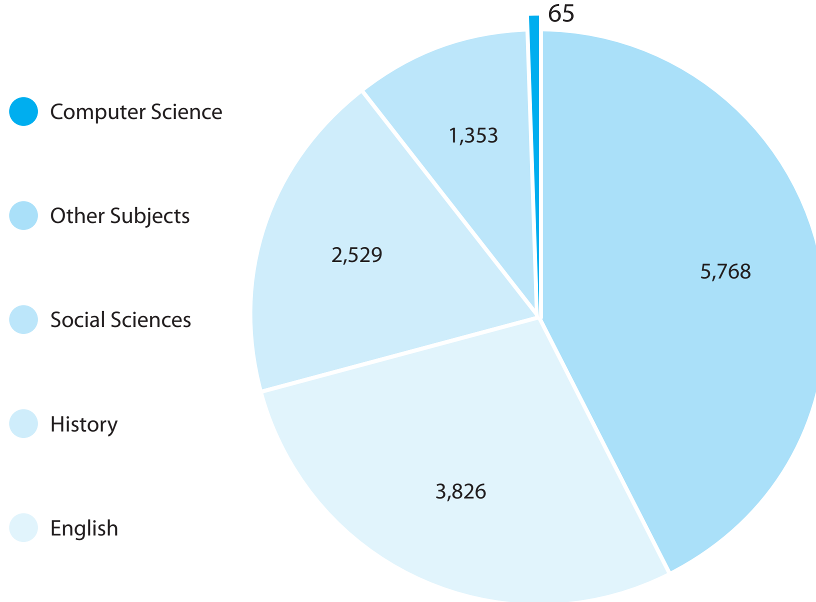
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Maine

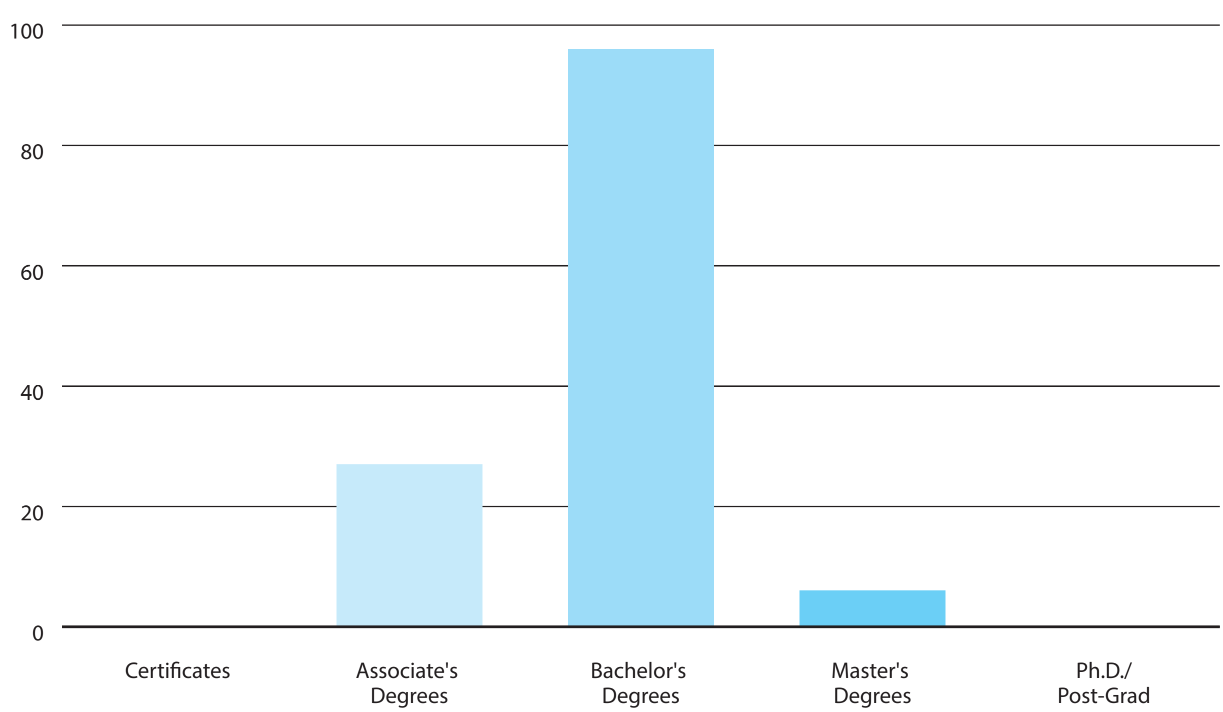
High School Graduation Requirements

Maine does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Maine in 2012

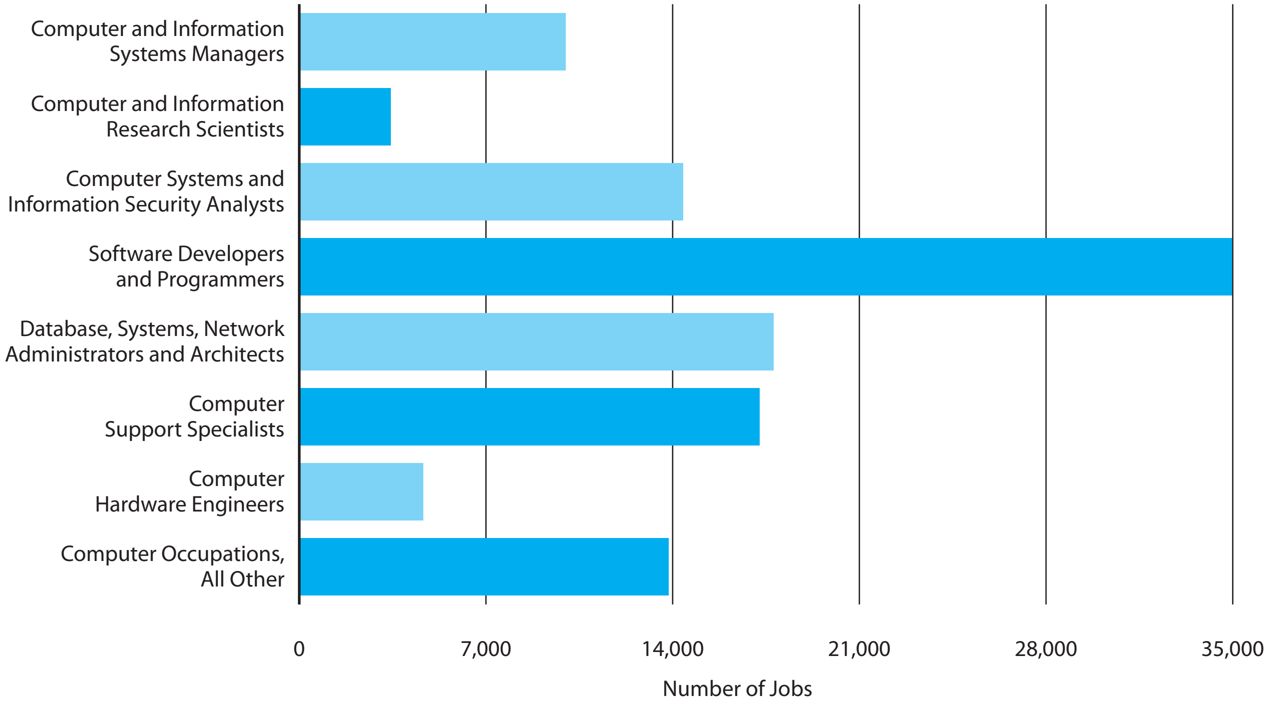


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Maine in 2012

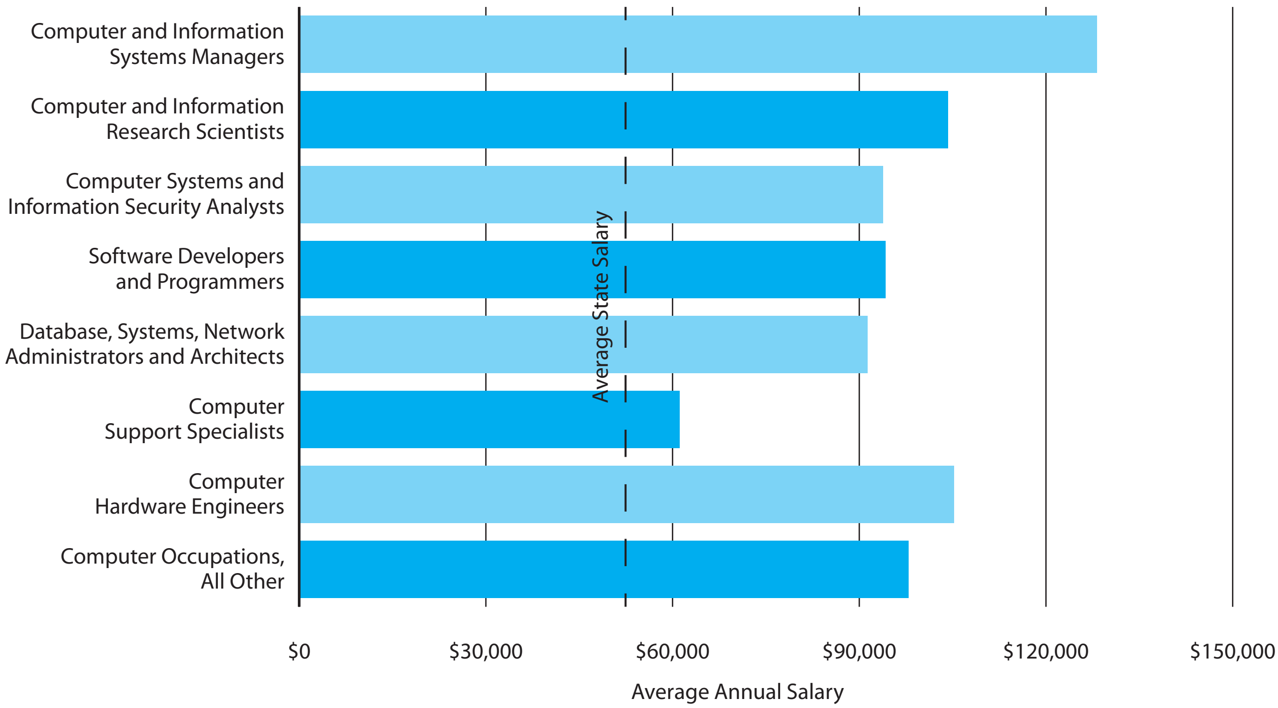


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Maryland in 2012



Average Annual Salaries in Computing in Maryland in 2012



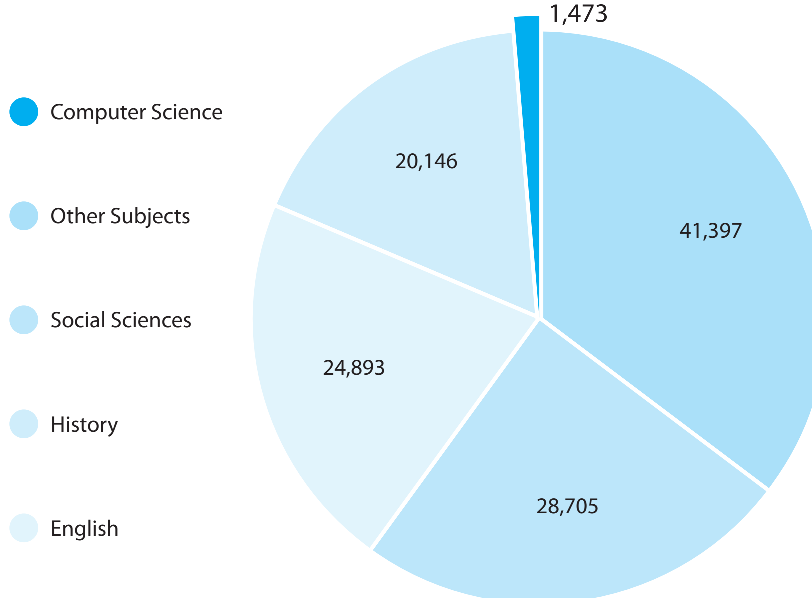
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Maryland

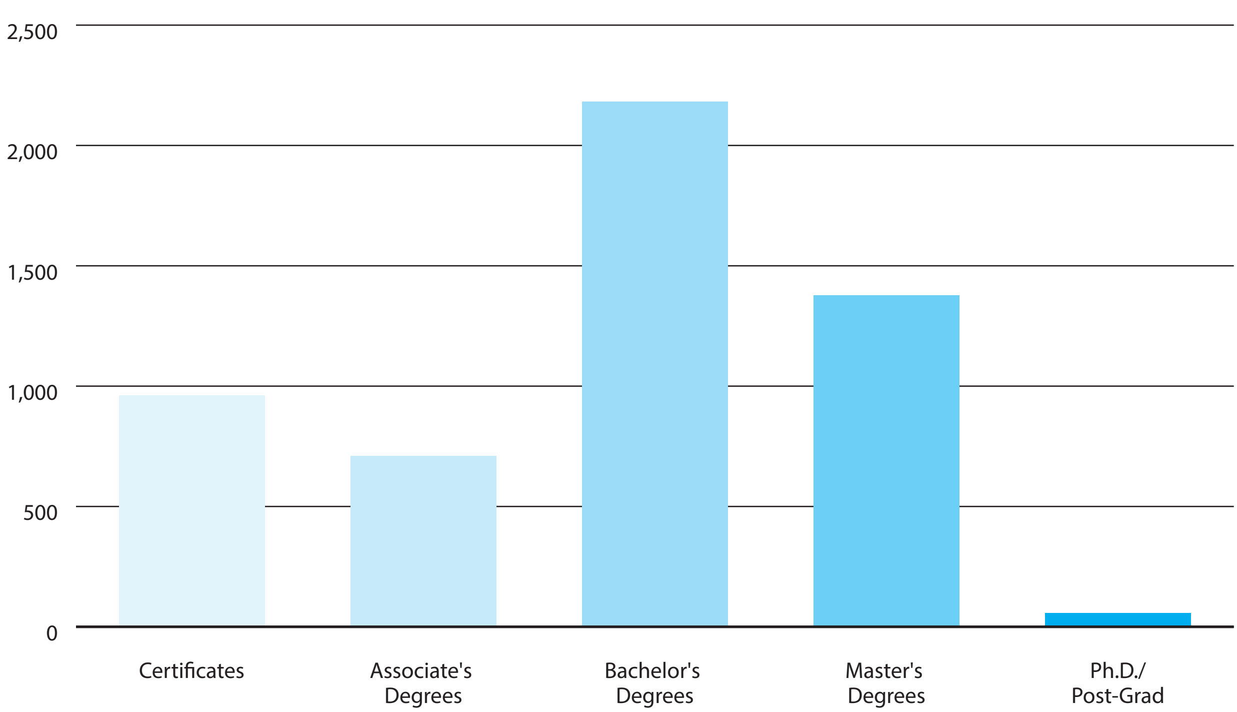
High School Graduation Requirements

Maryland does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Maryland in 2012

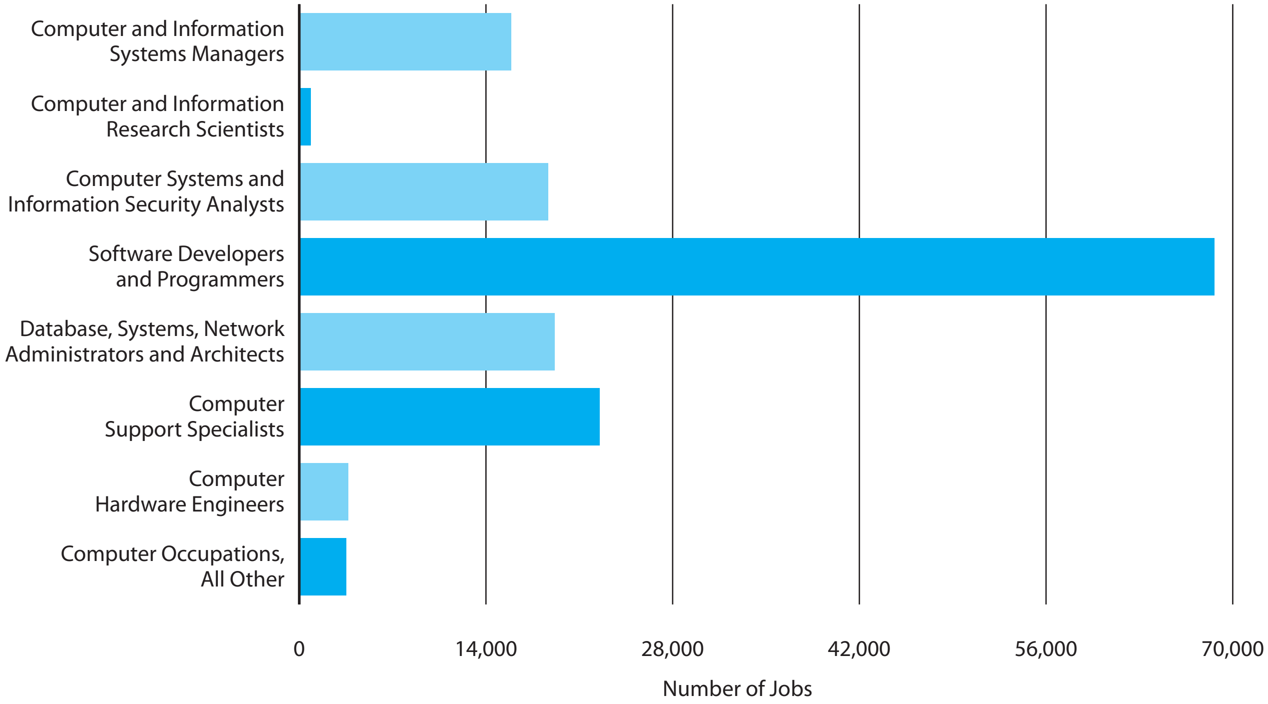


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Maryland in 2012

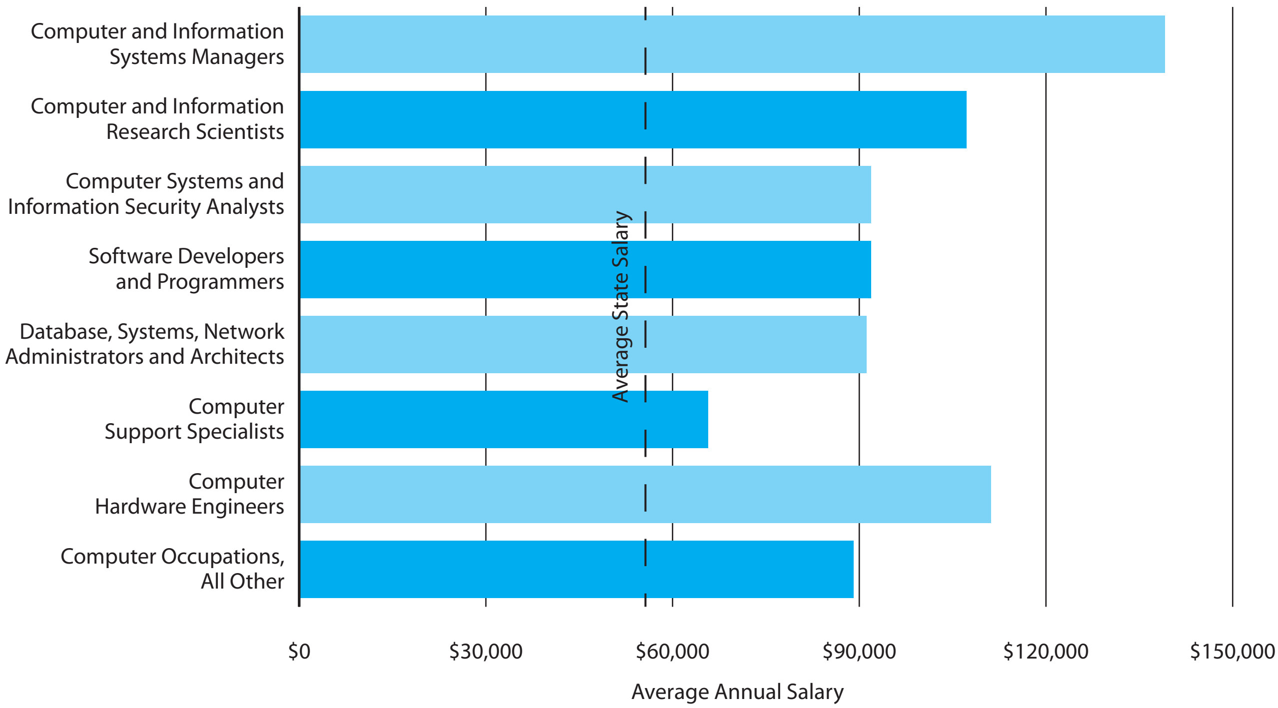


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Massachusetts in 2012



Average Annual Salaries in Computing in Massachusetts in 2012



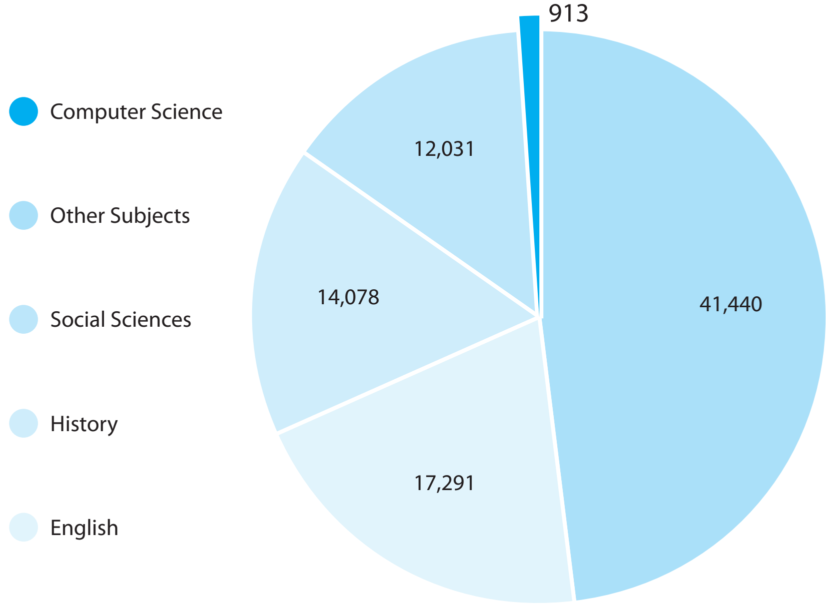
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Massachusetts

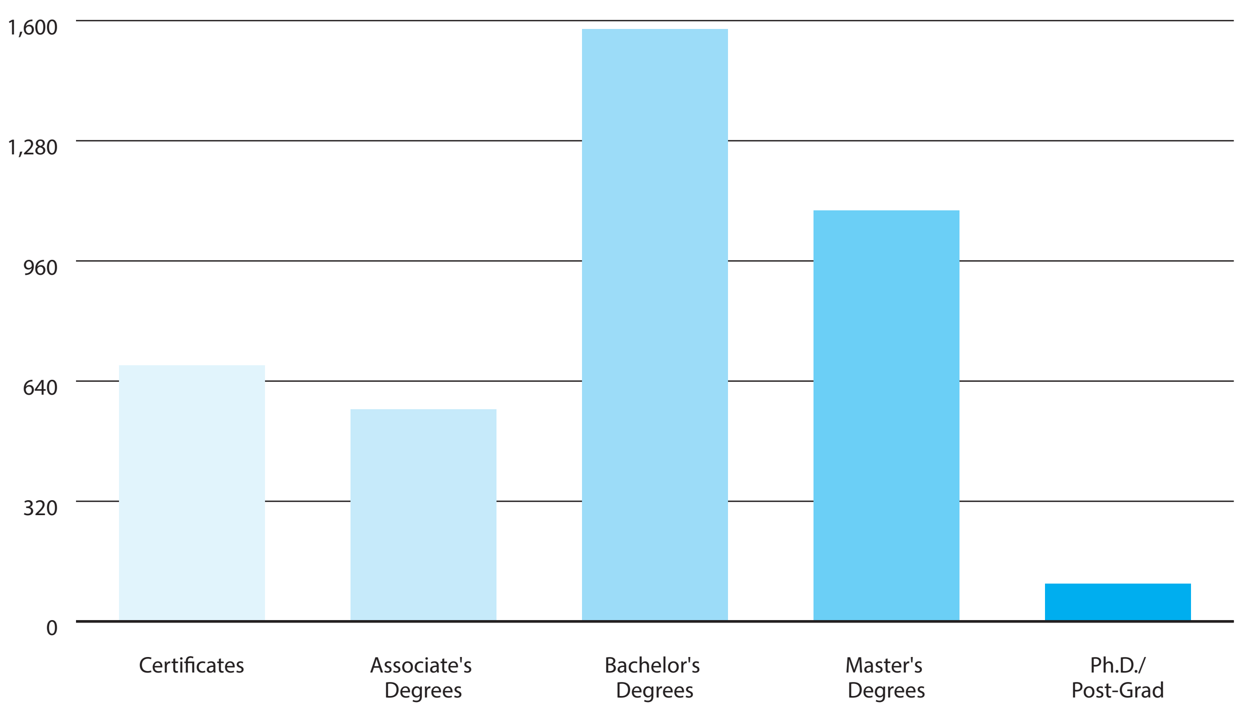
High School Graduation Requirements

Massachusetts does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Massachusetts in 2012



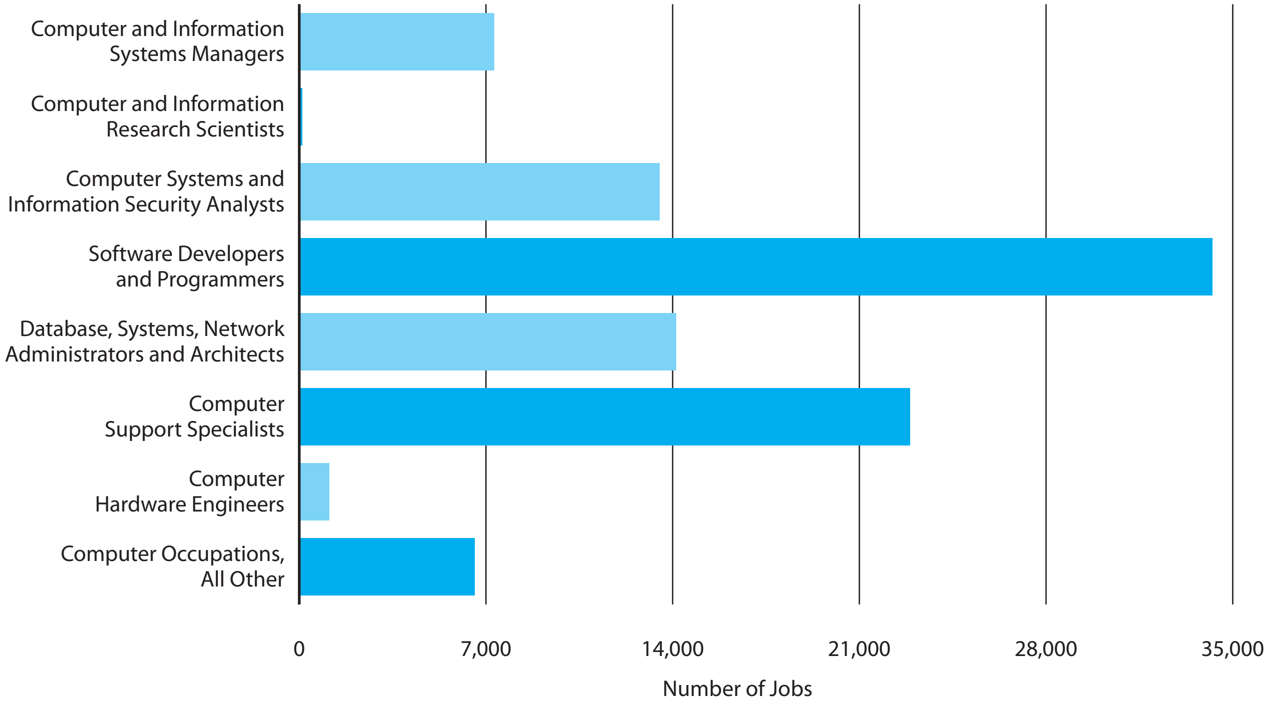
Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Massachusetts in 2012



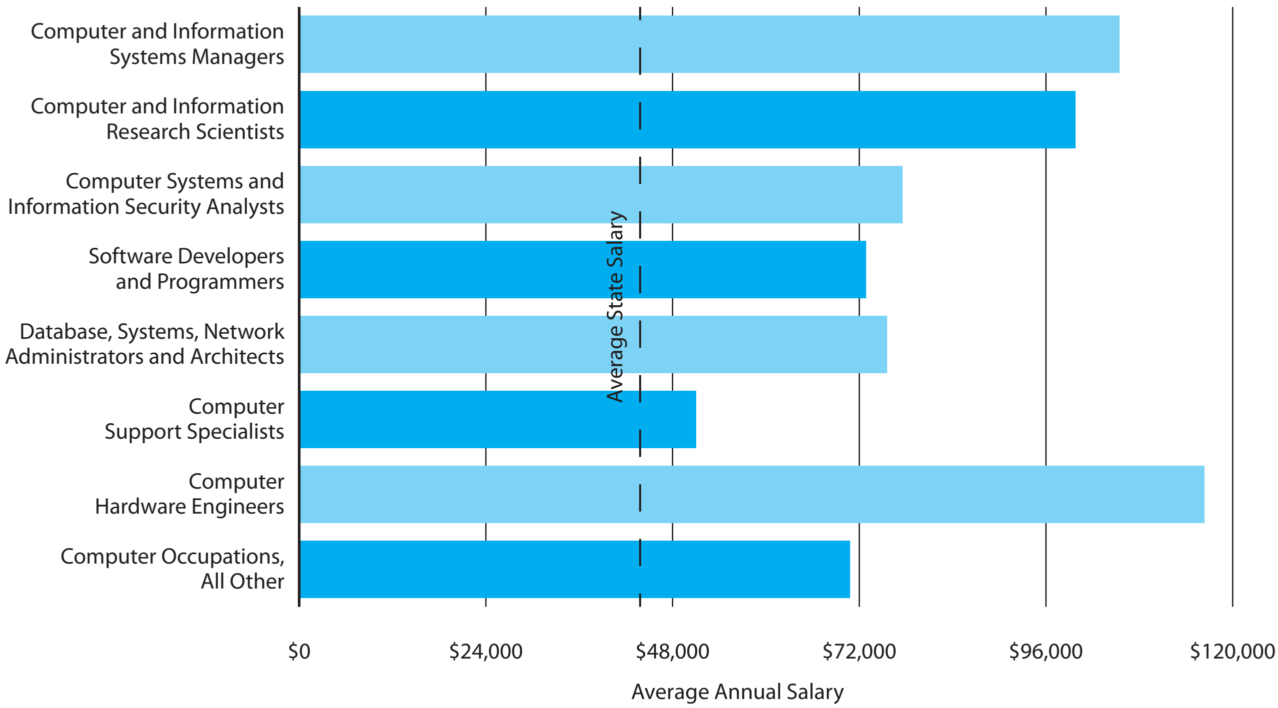
Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Michigan

Total Employment in Computing in Michigan in 2012



Average Annual Salaries in Computing in Michigan in 2012



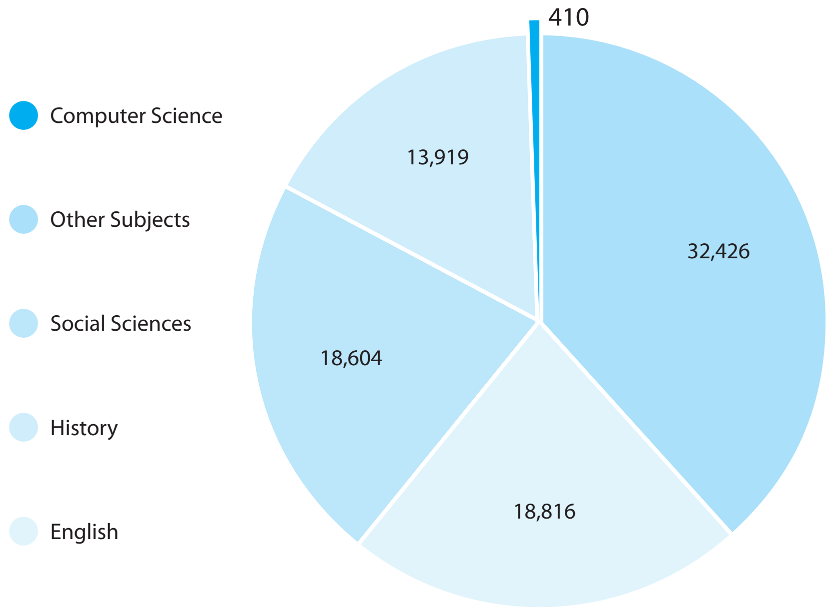
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Michigan

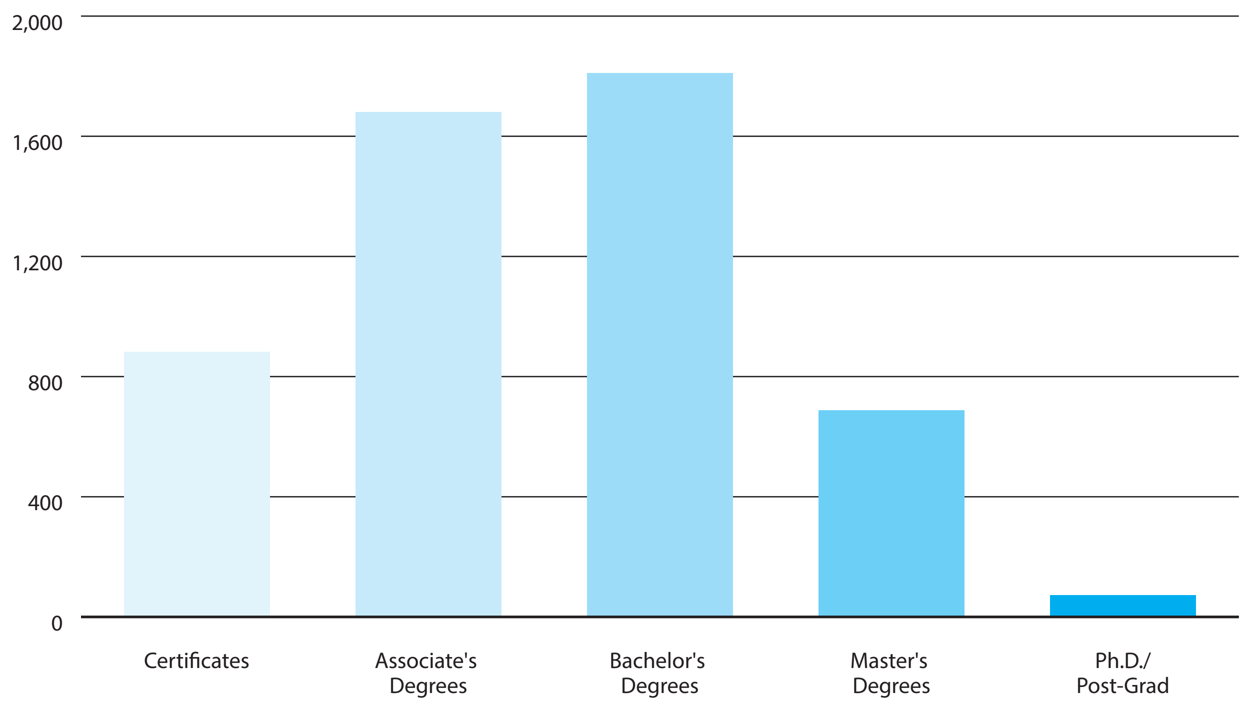
High School Graduation Requirements

Michigan clearly allows computer science to satisfy a core high school graduation requirement in mathematics.

Advanced Placement Exams in Michigan in 2012

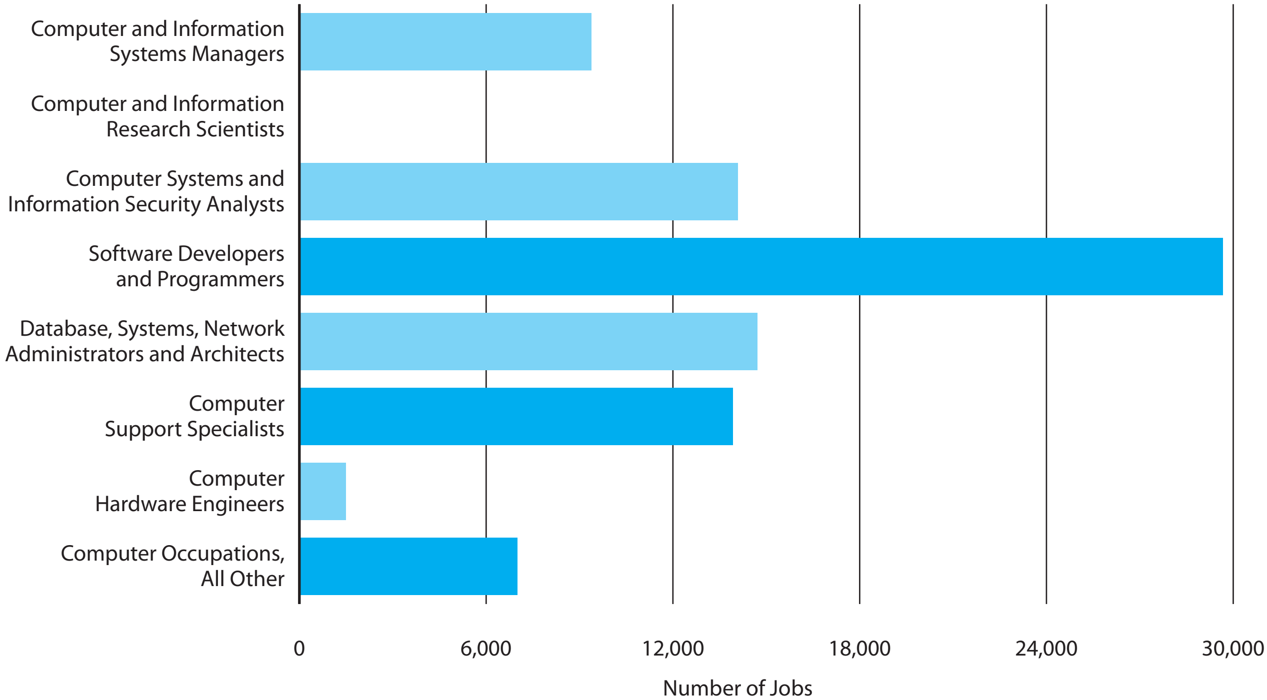


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Michigan in 2012

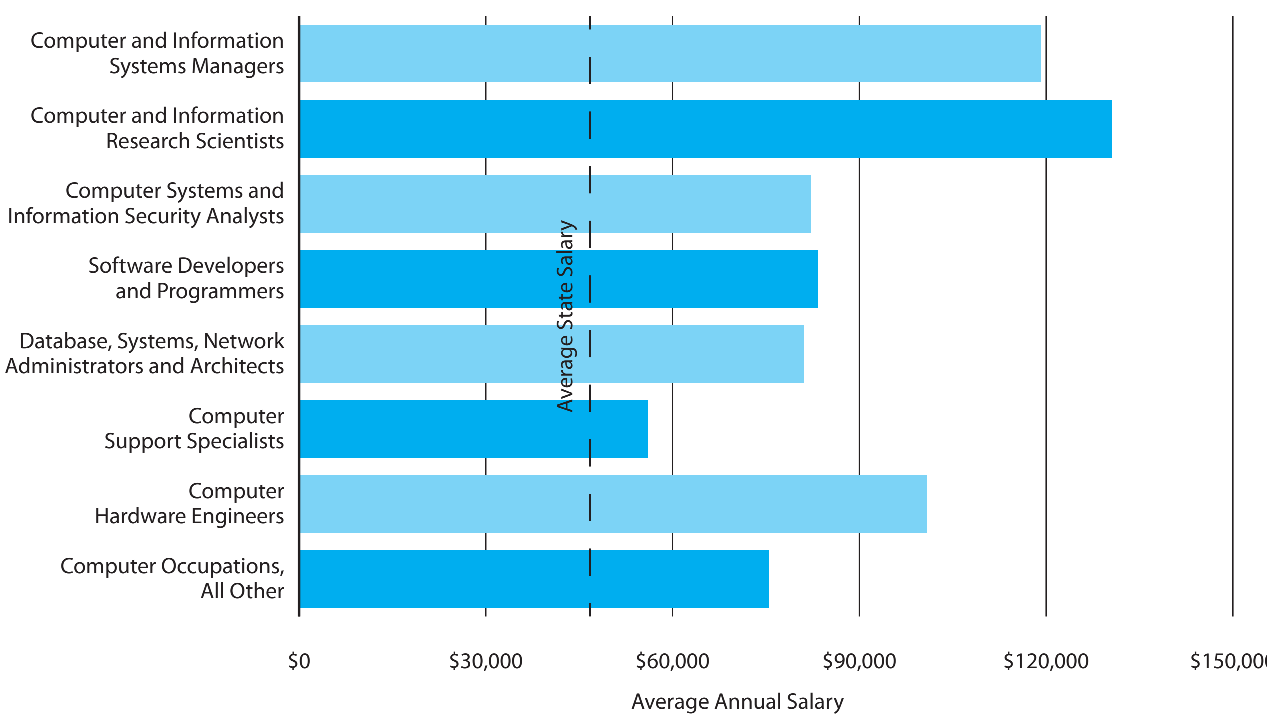


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Minnesota in 2012



Average Annual Salaries in Computing in Minnesota in 2012



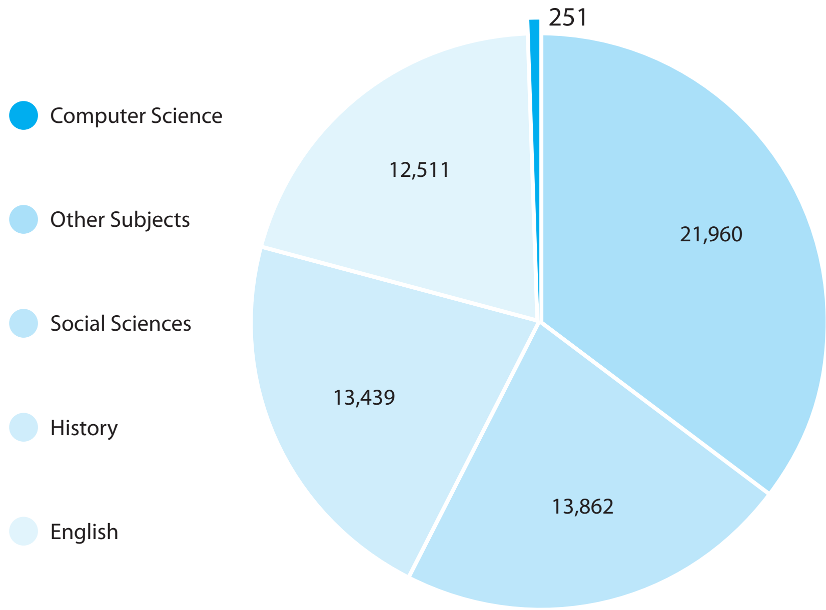
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Minnesota

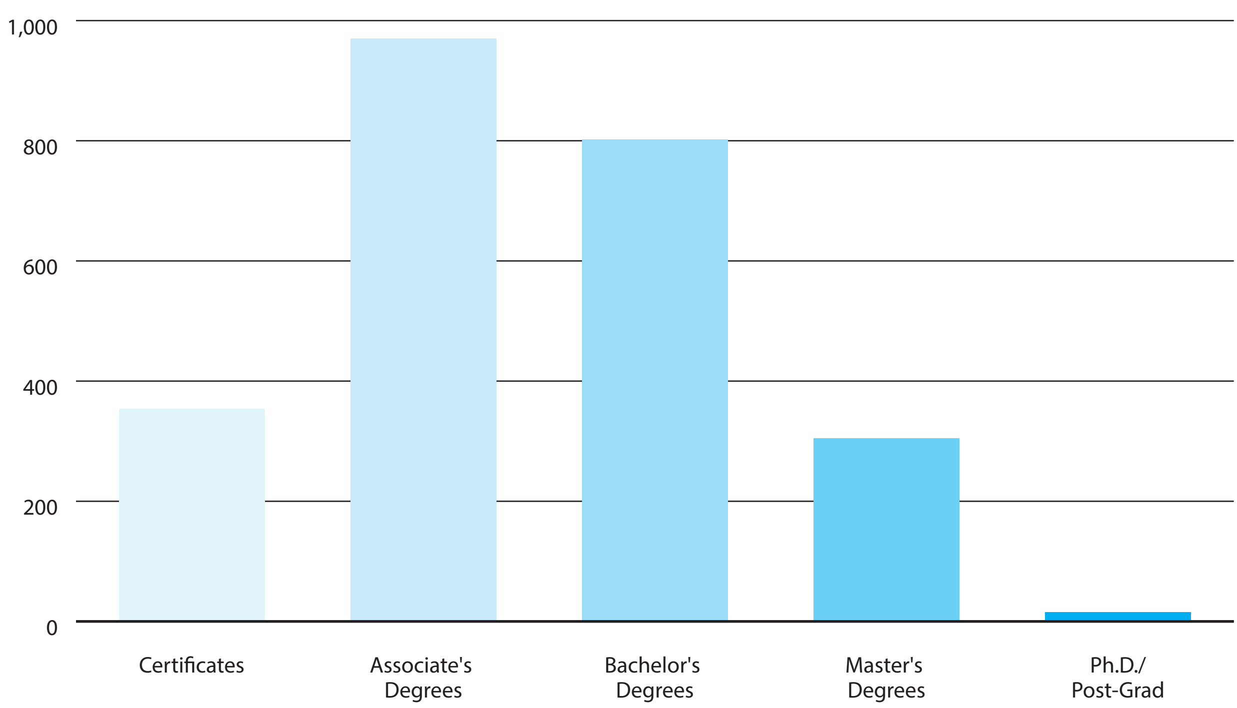
High School Graduation Requirements

Minnesota does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Minnesota in 2012

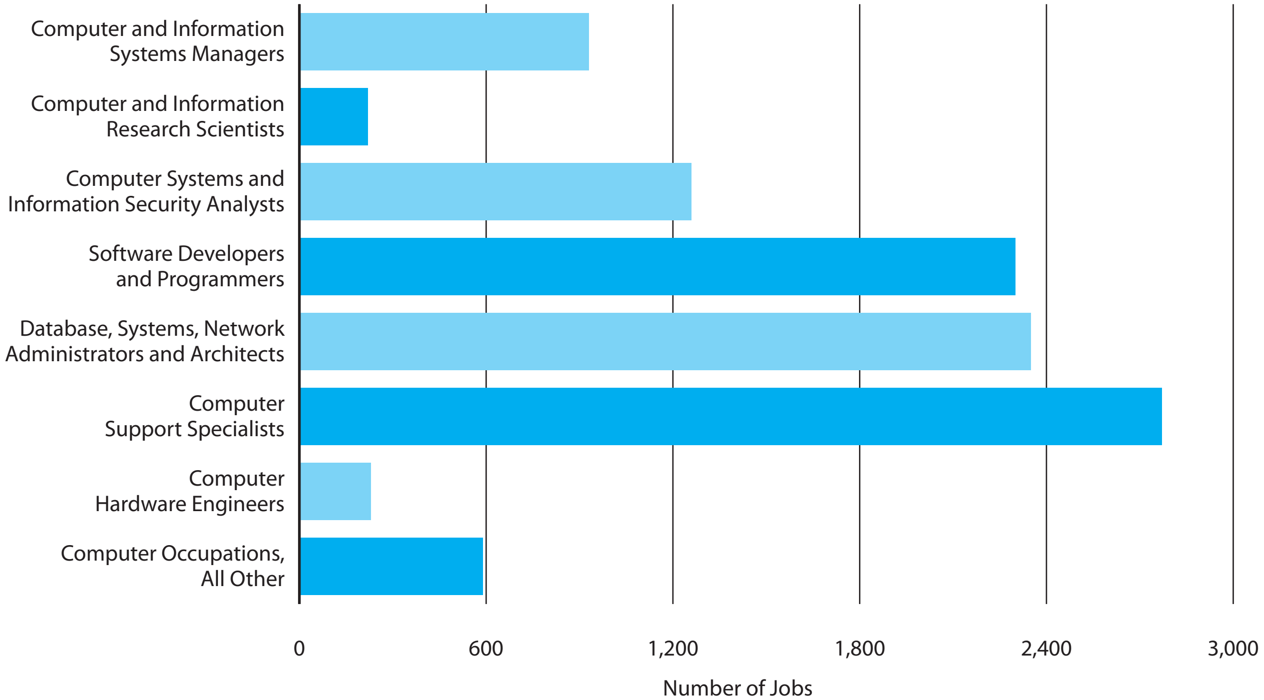


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Minnesota in 2012

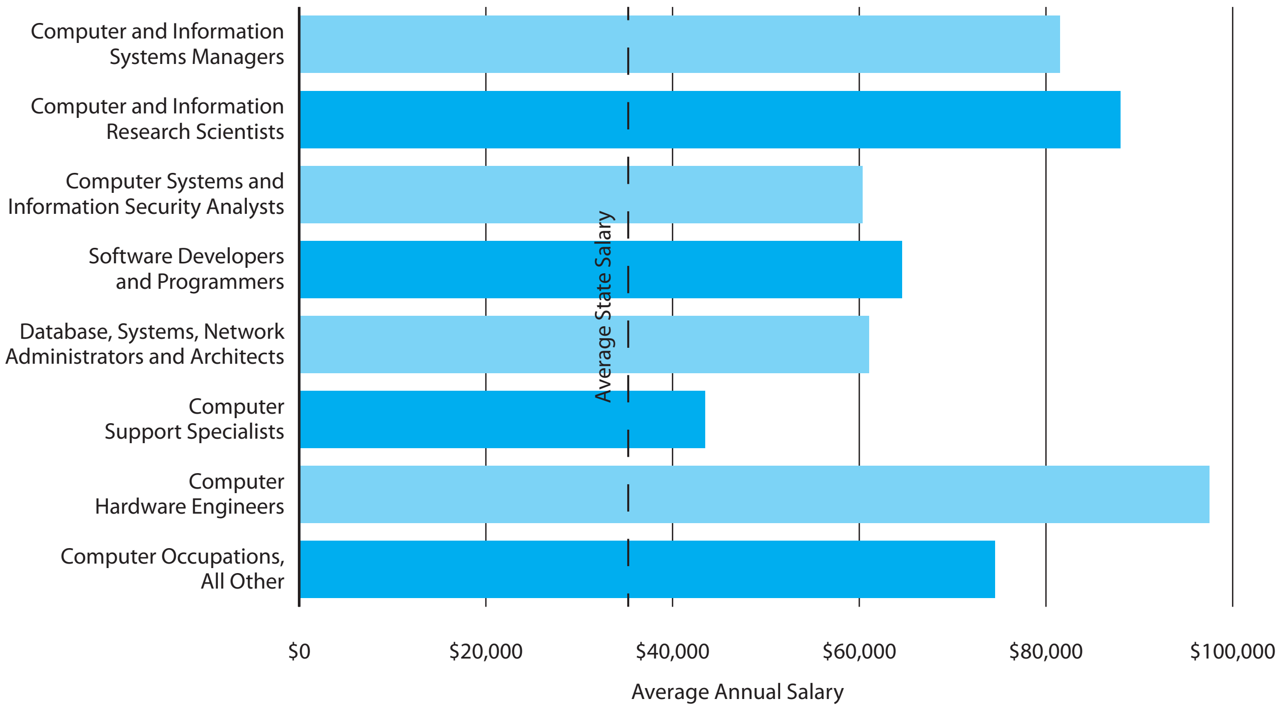


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Mississippi in 2012



Average Annual Salaries in Computing in Mississippi in 2012



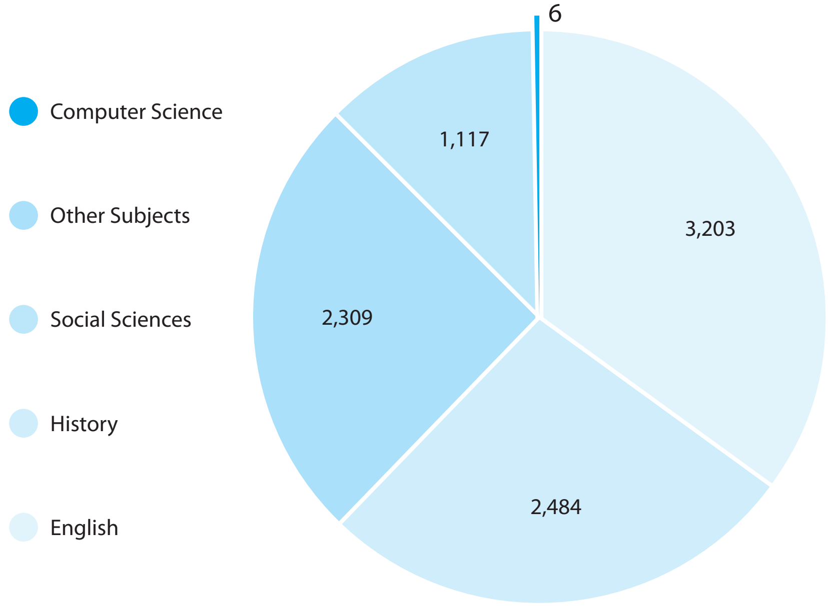
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Mississippi

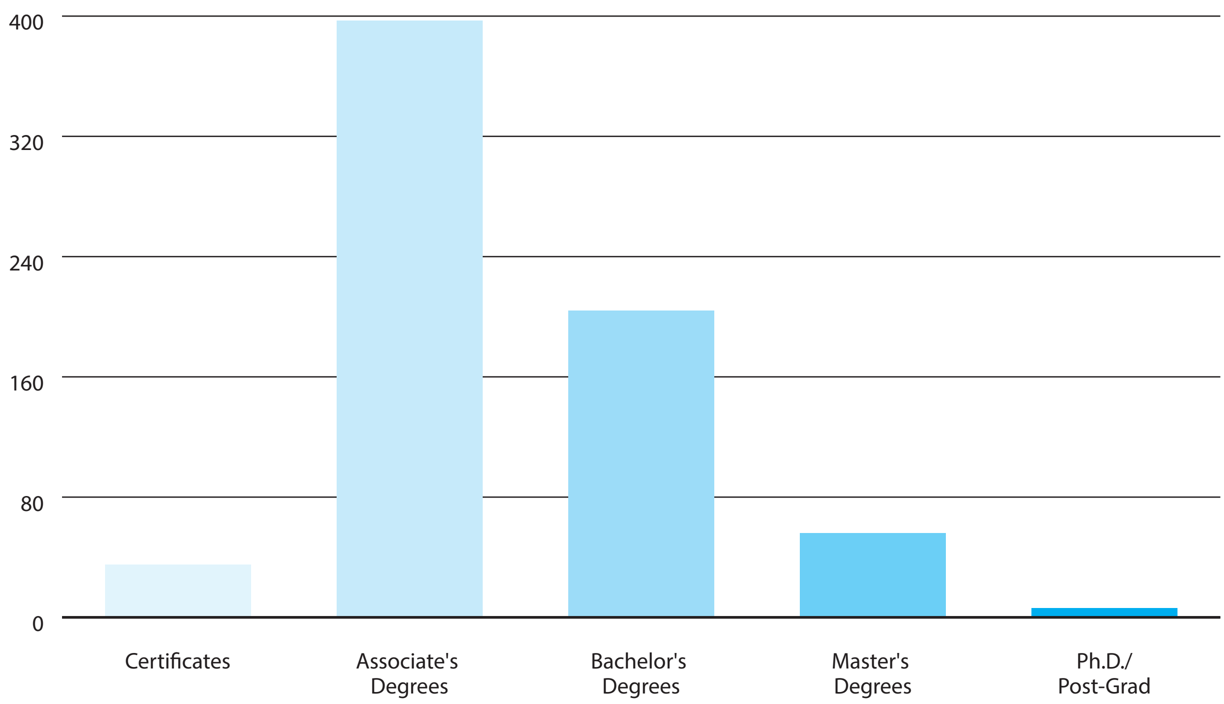
High School Graduation Requirements

Mississippi does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Mississippi in 2012

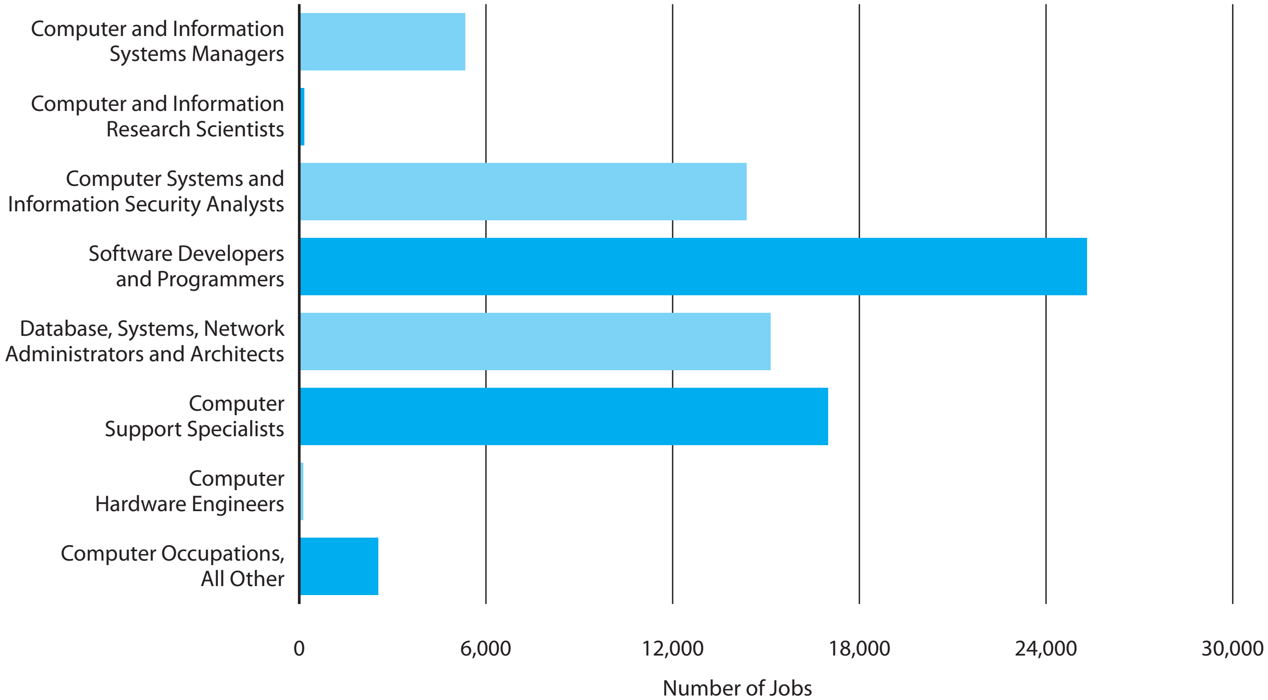


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Mississippi in 2012

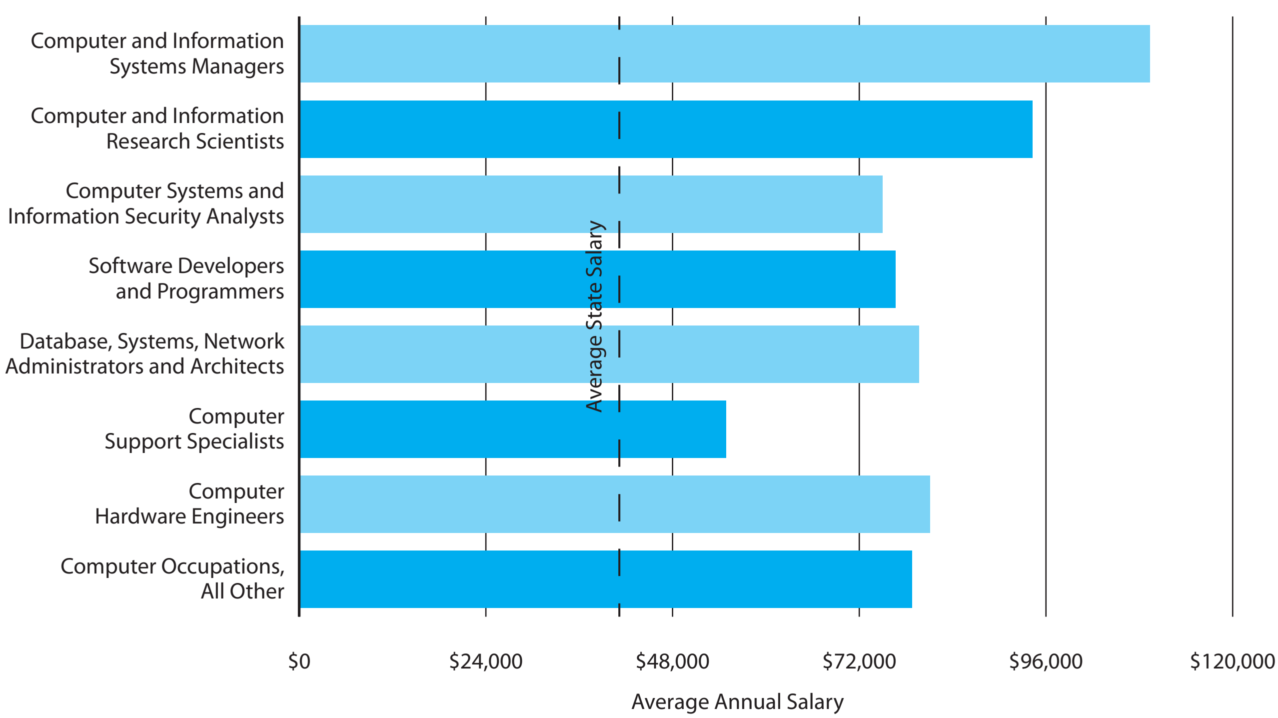


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Missouri in 2012



Average Annual Salaries in Computing in Missouri in 2012



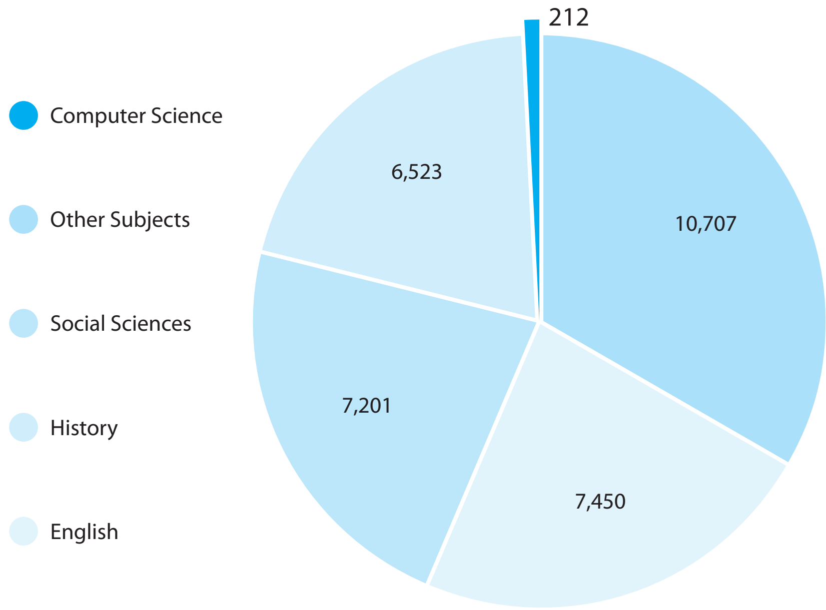
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Missouri

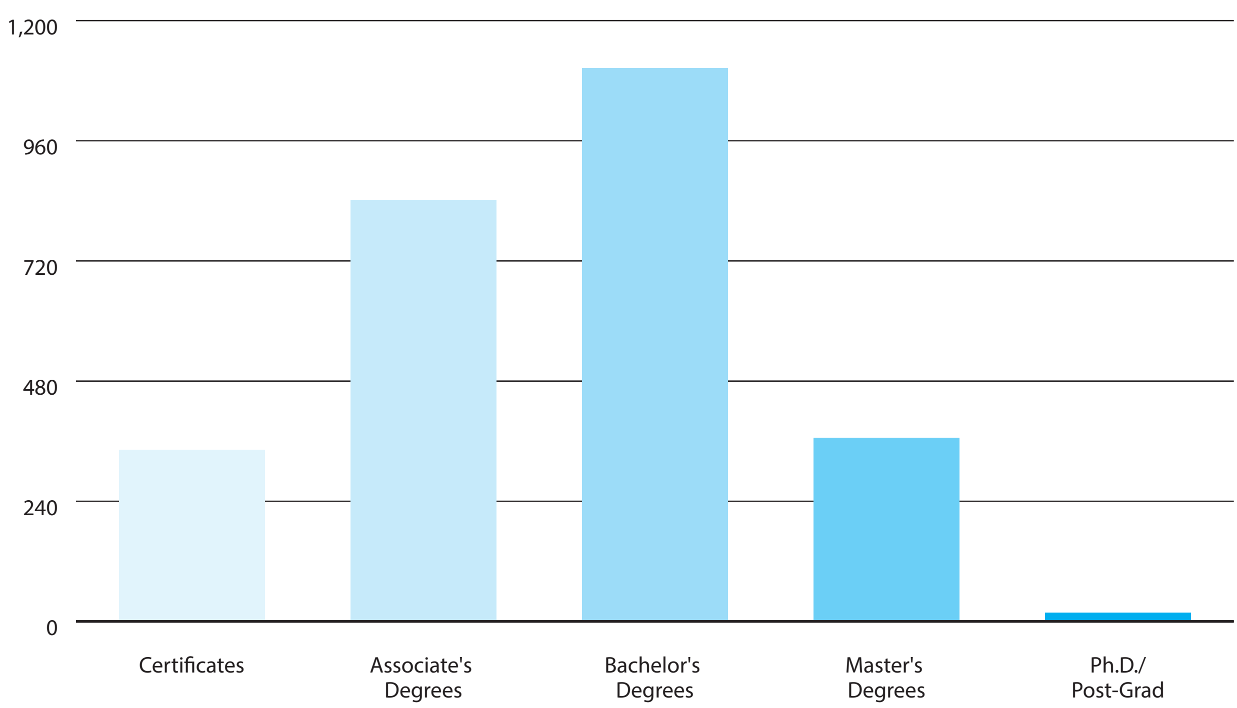
High School Graduation Requirements

Missouri clearly allows computer science to satisfy a core high school graduation requirement in mathematics.

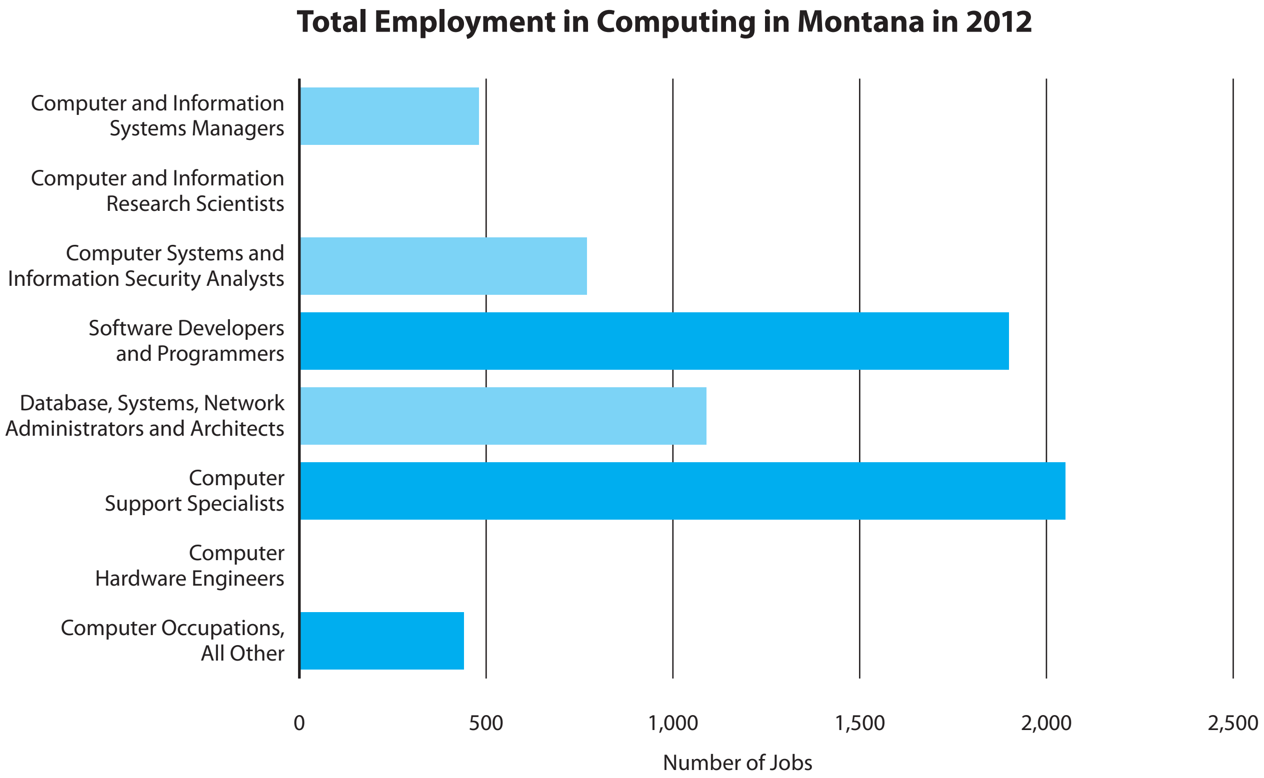
Advanced Placement Exams in Missouri in 2012

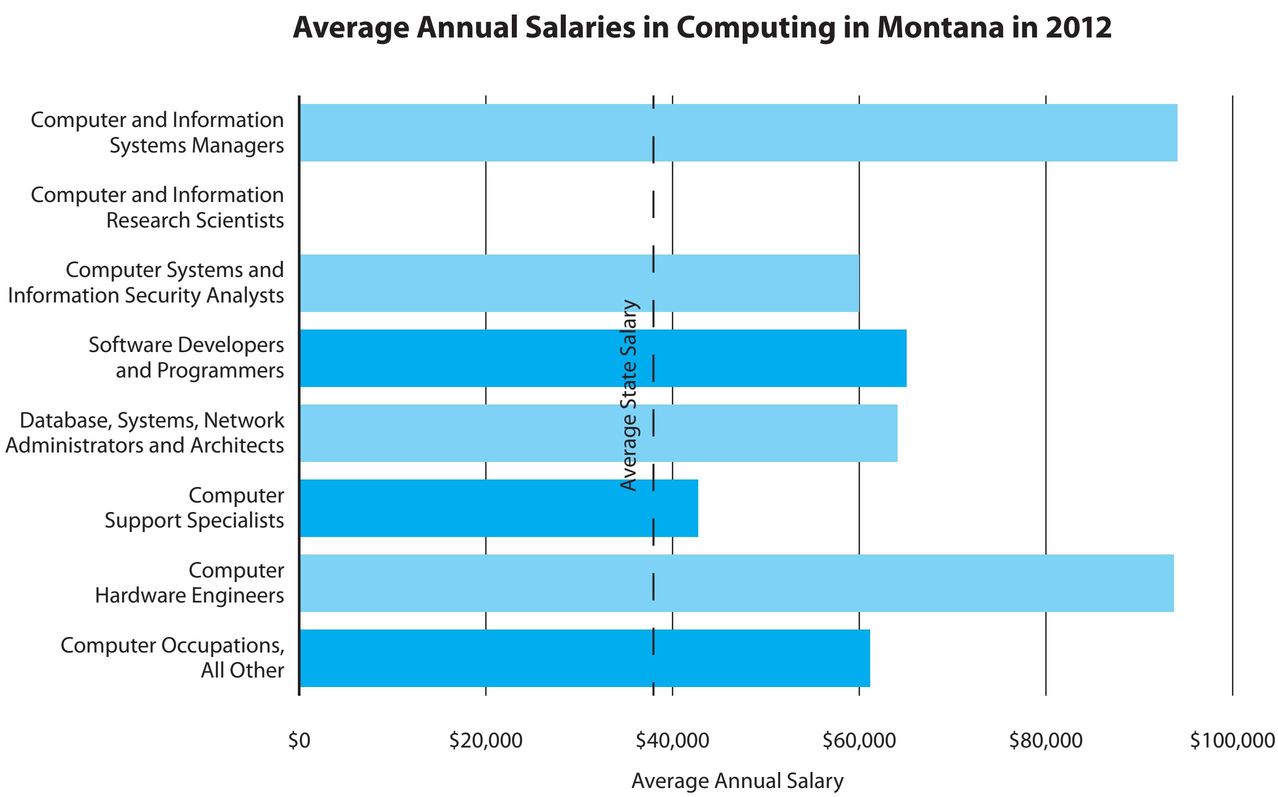


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Missouri in 2012



Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).





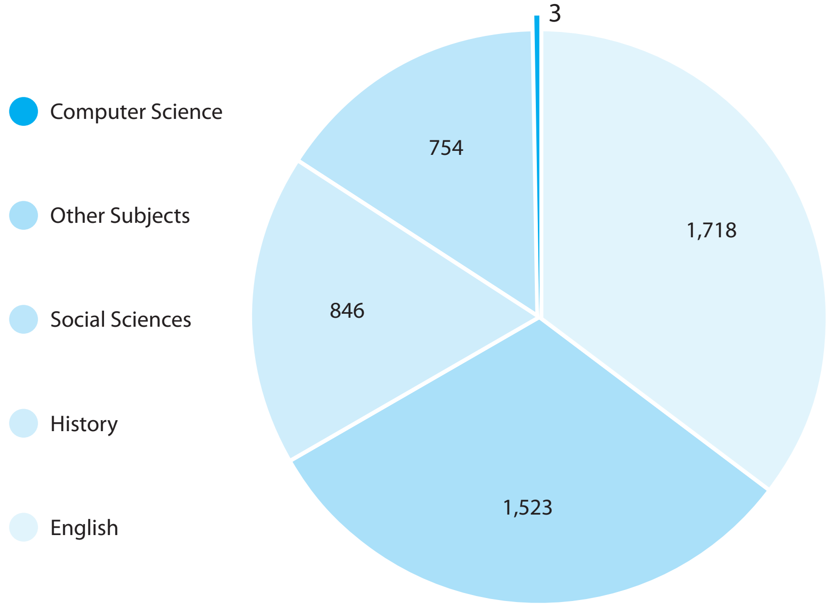
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Montana

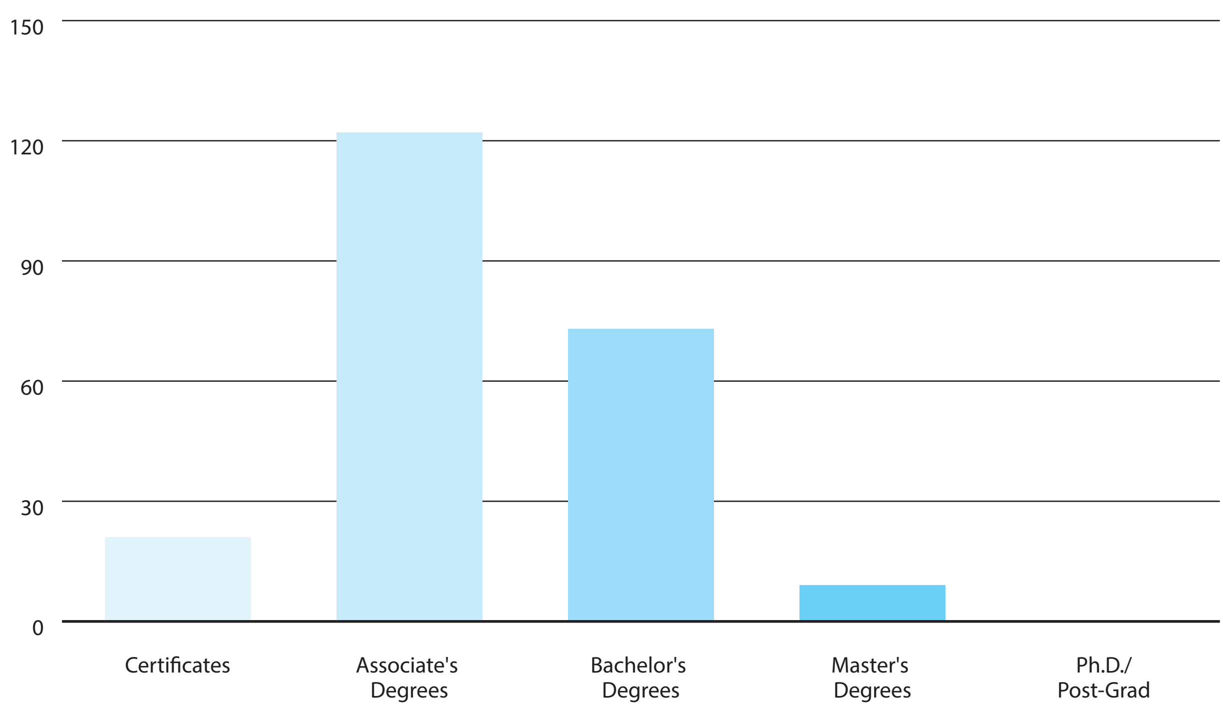
High School Graduation Requirements

Montana does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Montana in 2012

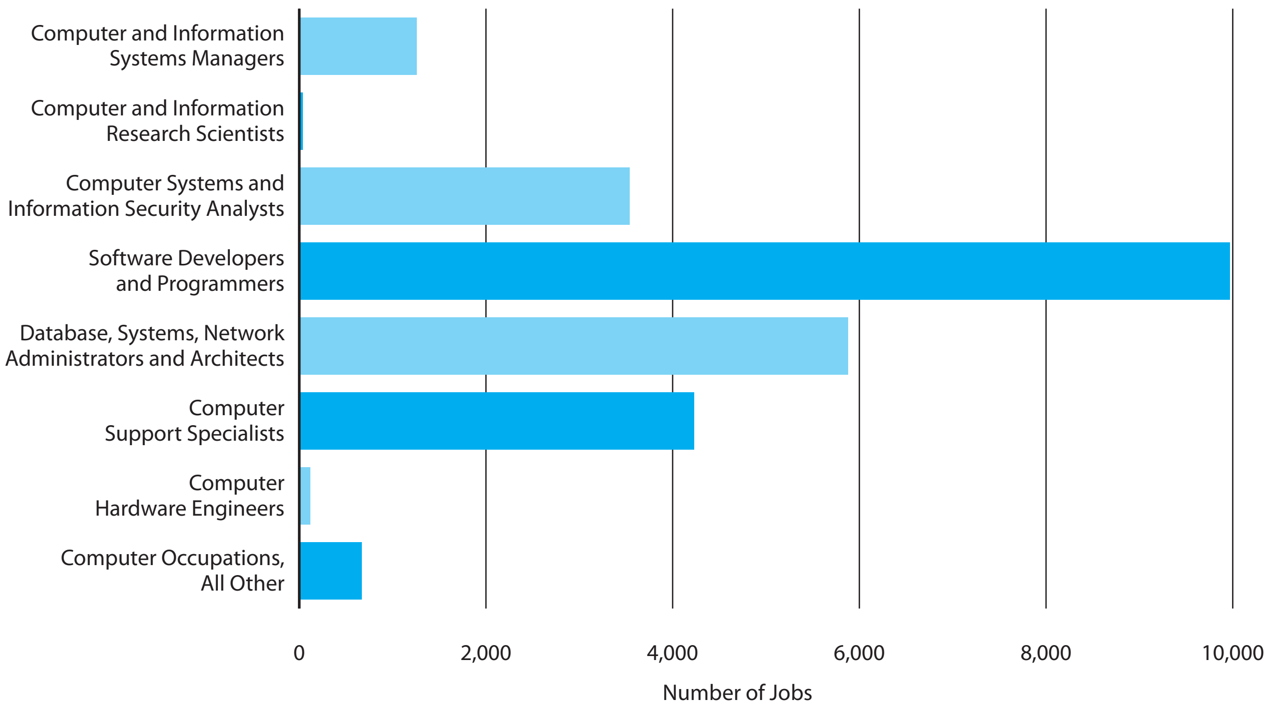


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Montana in 2012

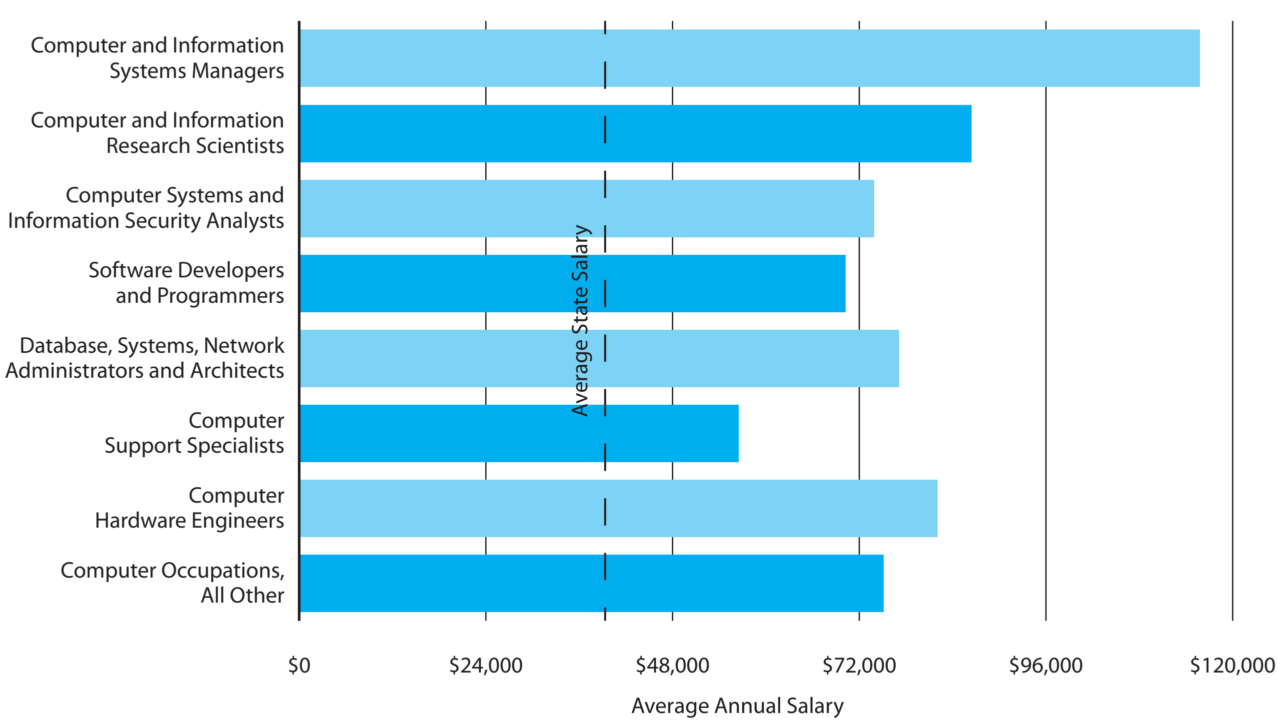


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Nebraska in 2012



Average Annual Salaries in Computing in Nebraska in 2012



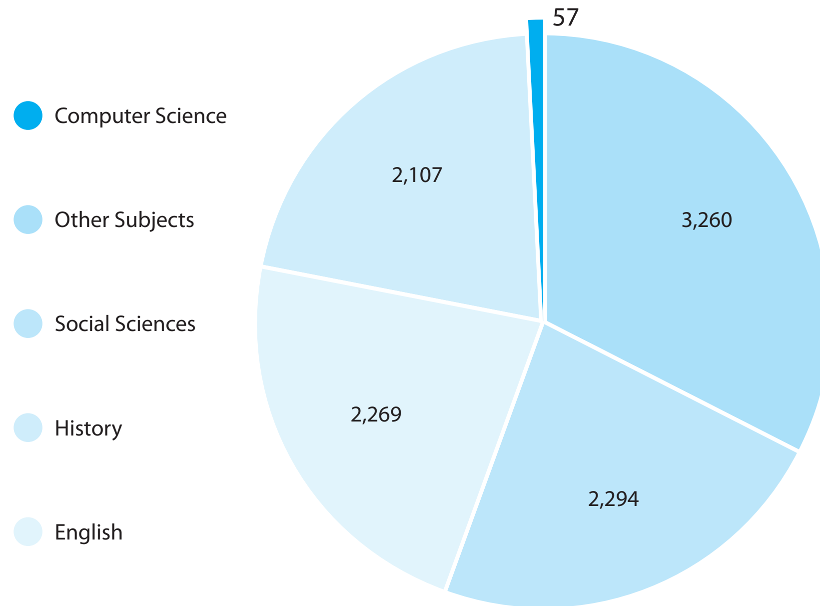
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Nebraska

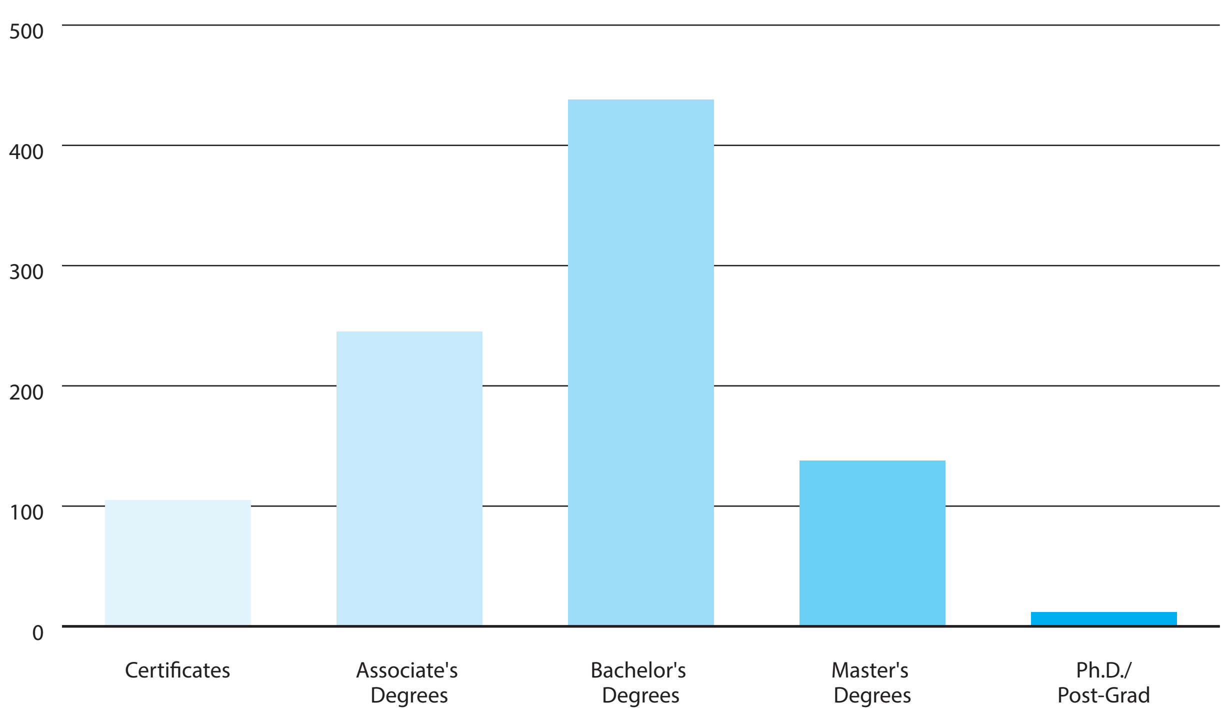
High School Graduation Requirements

Nebraska does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Nebraska in 2012

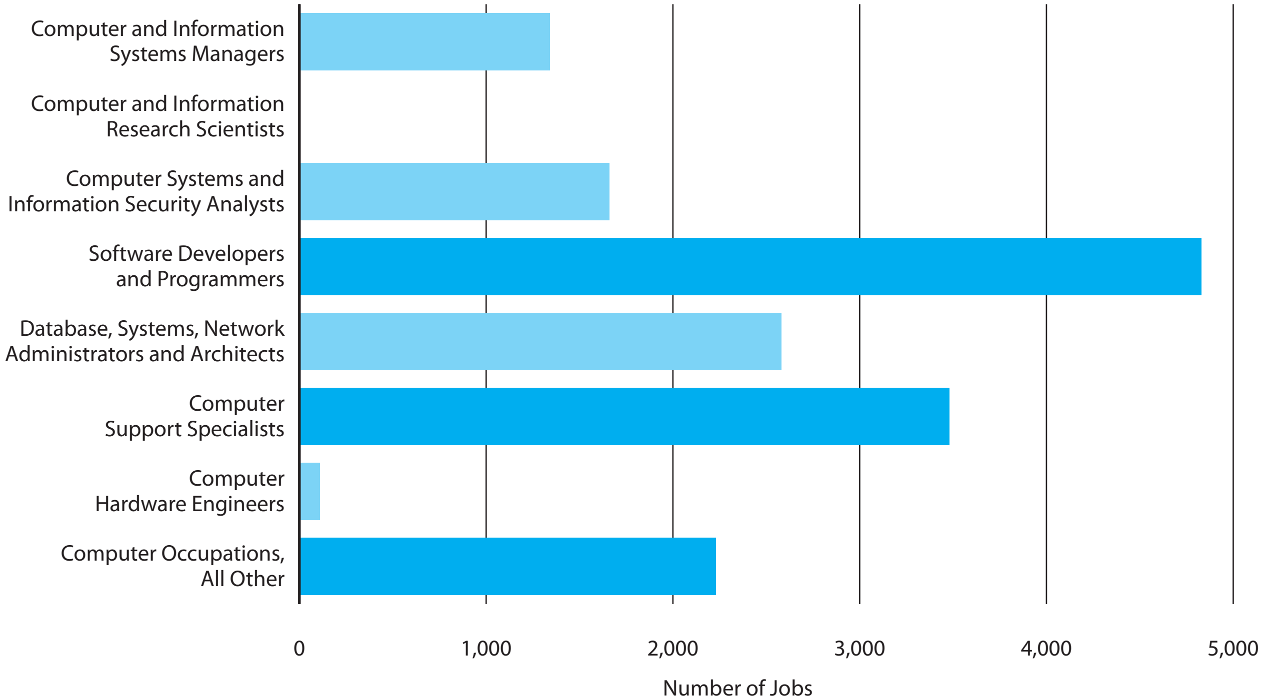


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Nebraska in 2012

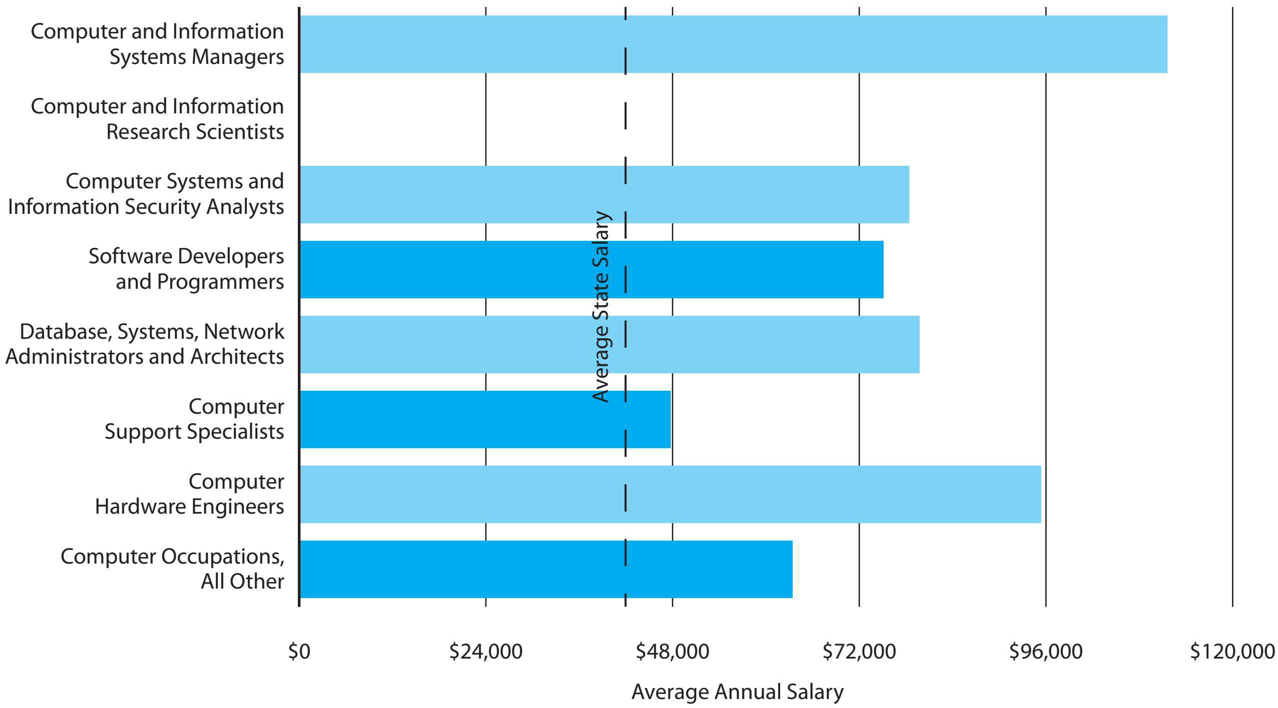


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Nevada in 2012



Average Annual Salaries in Computing in Nevada in 2012



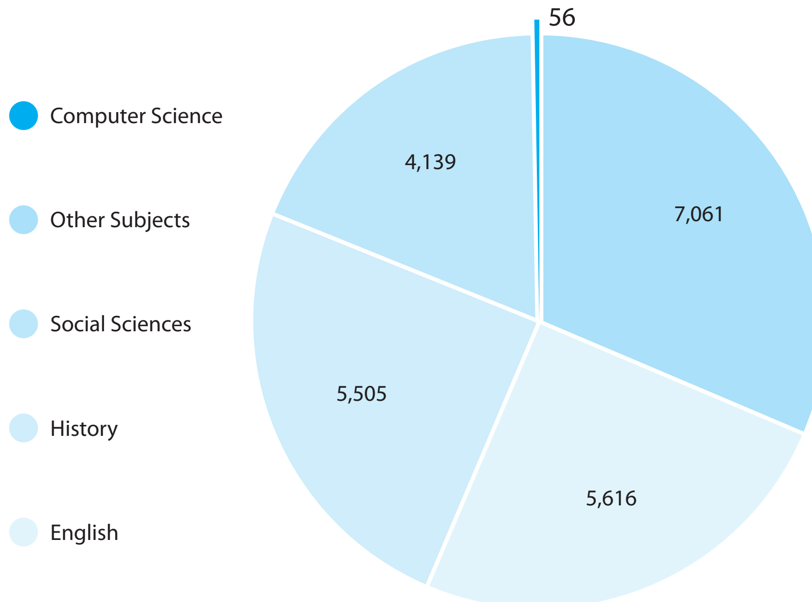
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Nevada

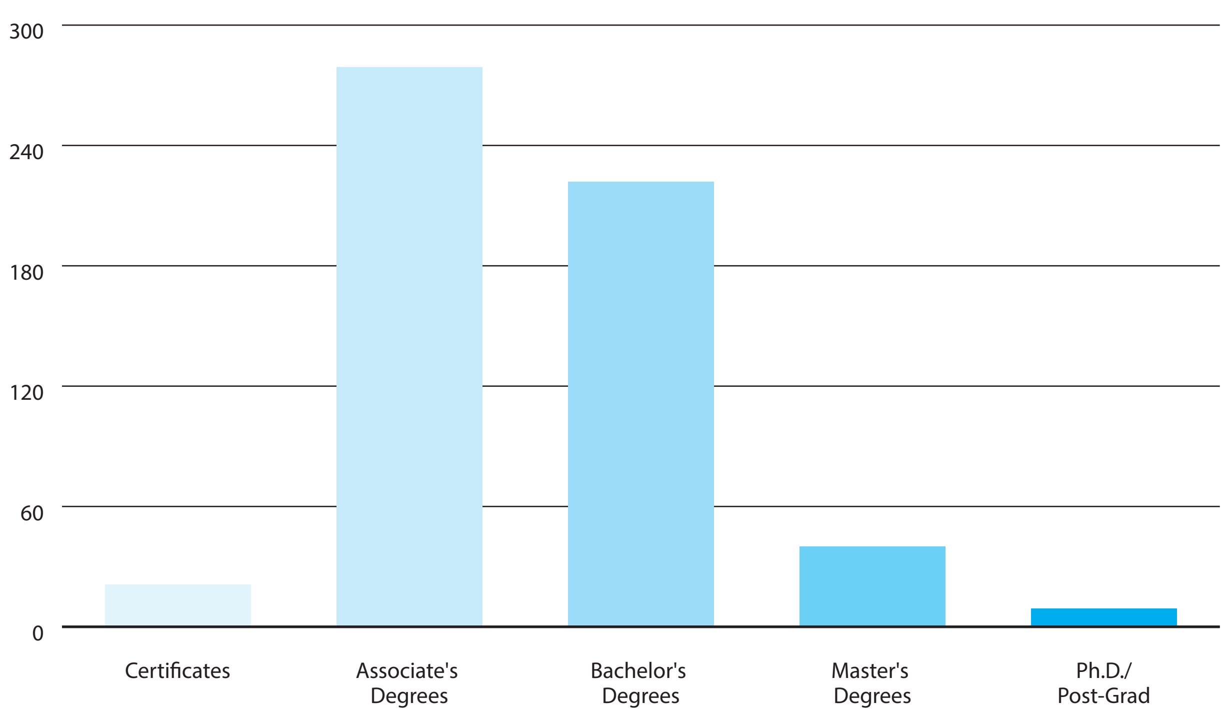
High School Graduation Requirements

Nevada does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

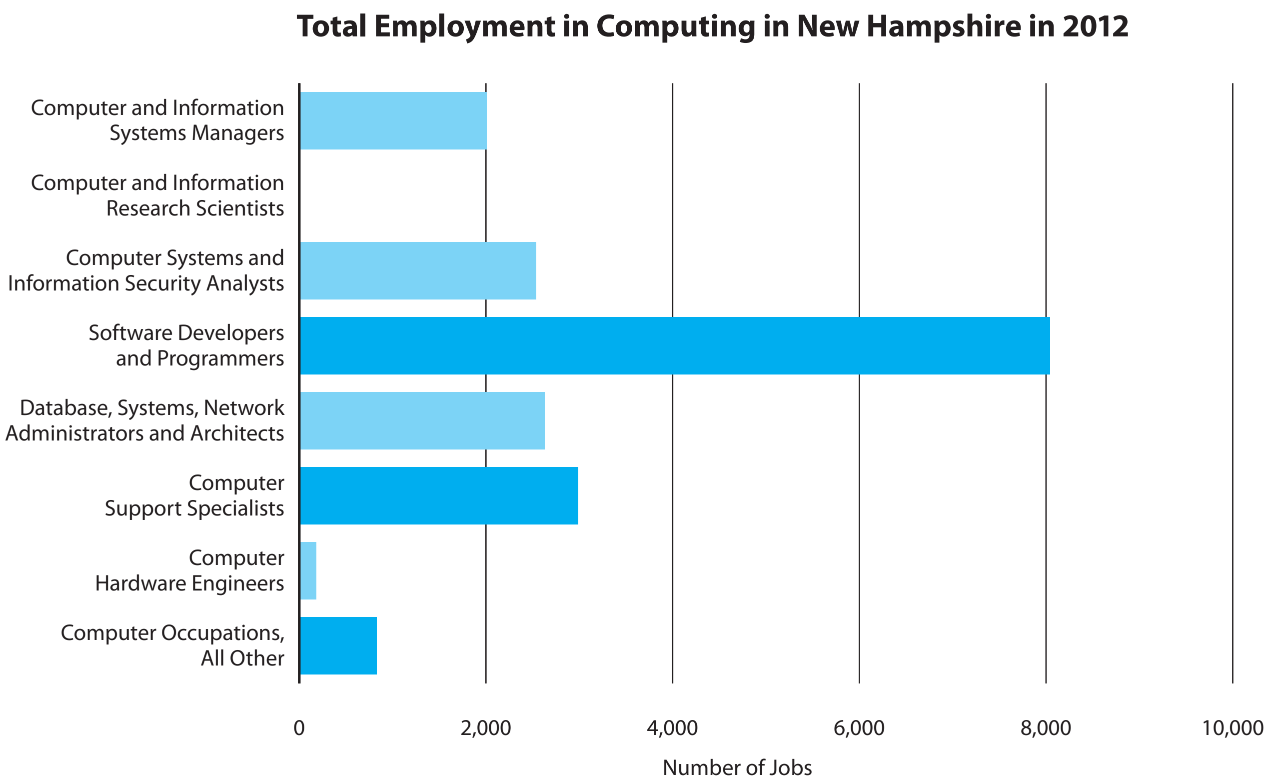
Advanced Placement Exams in Nevada in 2012

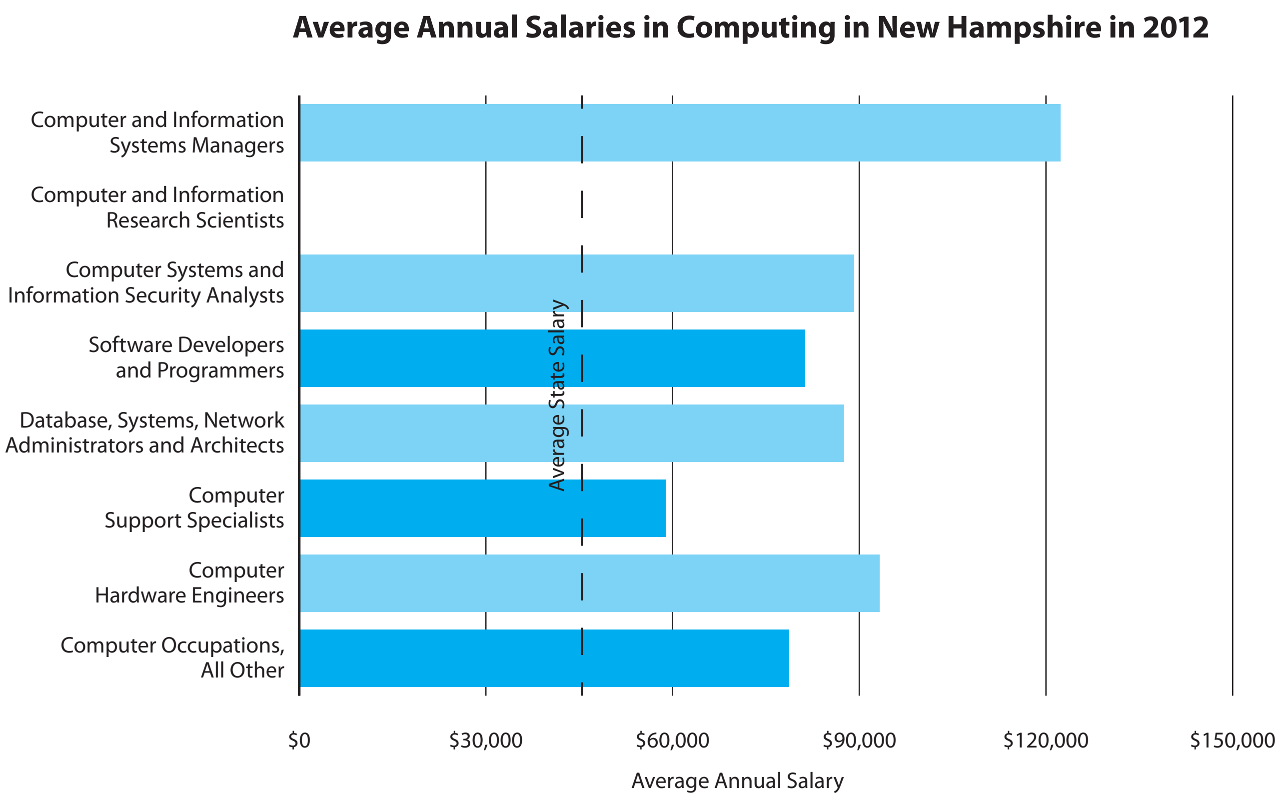


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Nevada in 2012



Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).





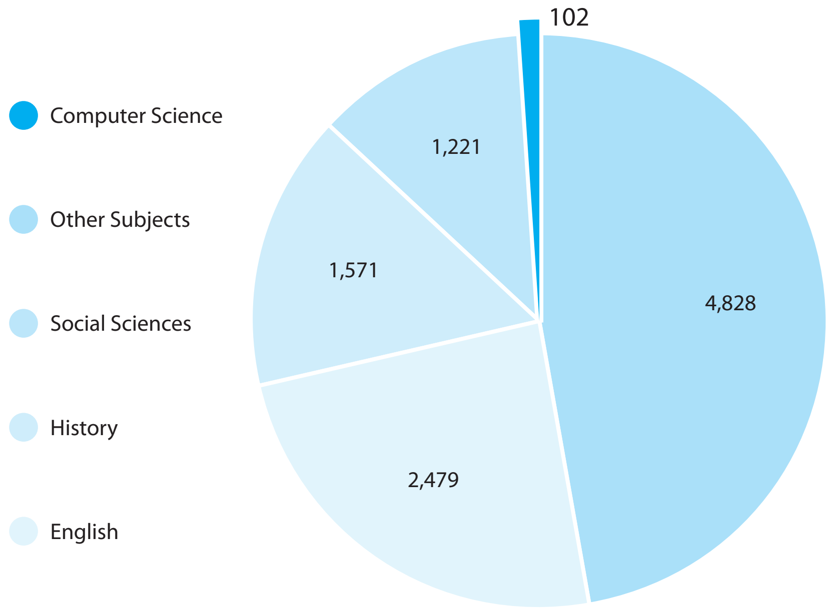
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

New Hampshire

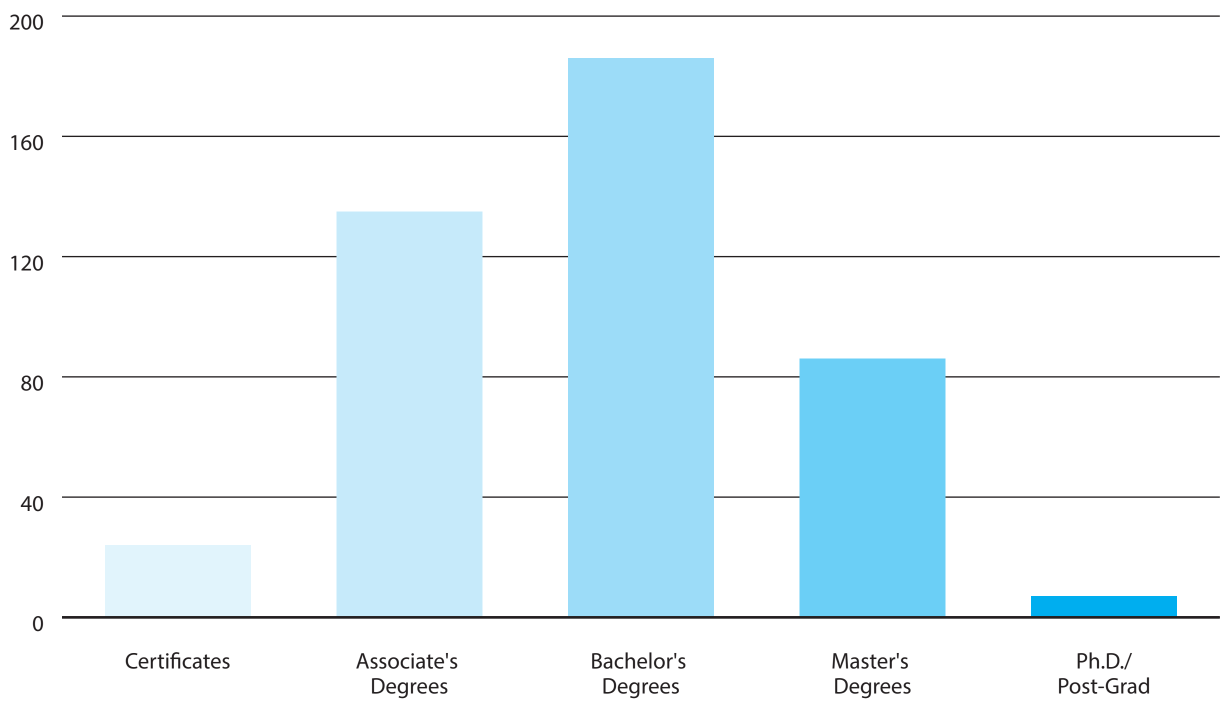
High School Graduation Requirements

New Hampshire does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in New Hampshire in 2012

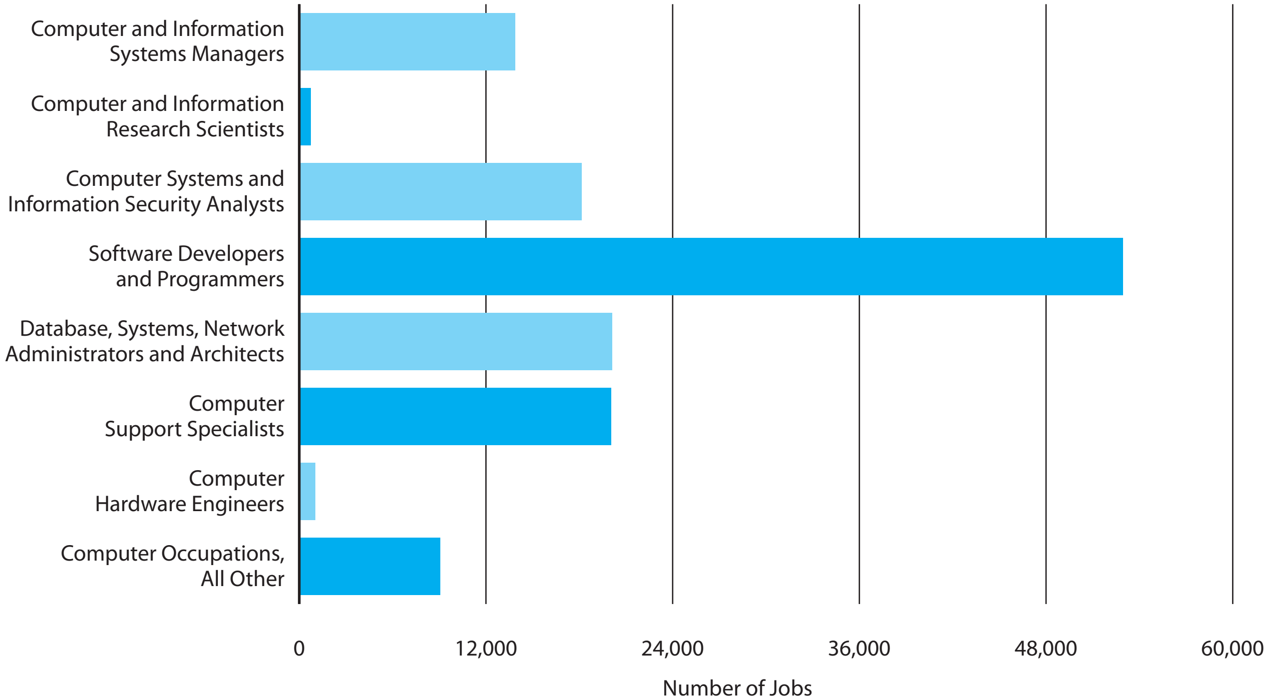


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in New Hampshire in 2012

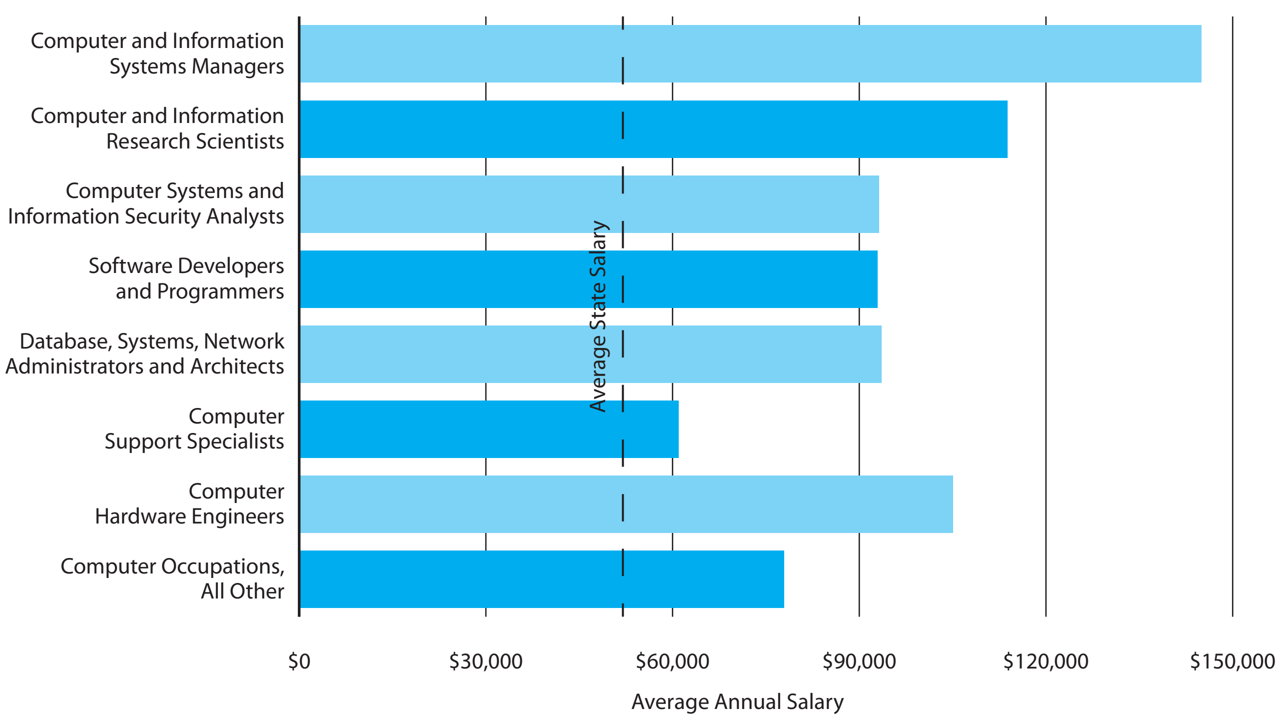


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in New Jersey in 2012



Average Annual Salaries in Computing in New Jersey in 2012



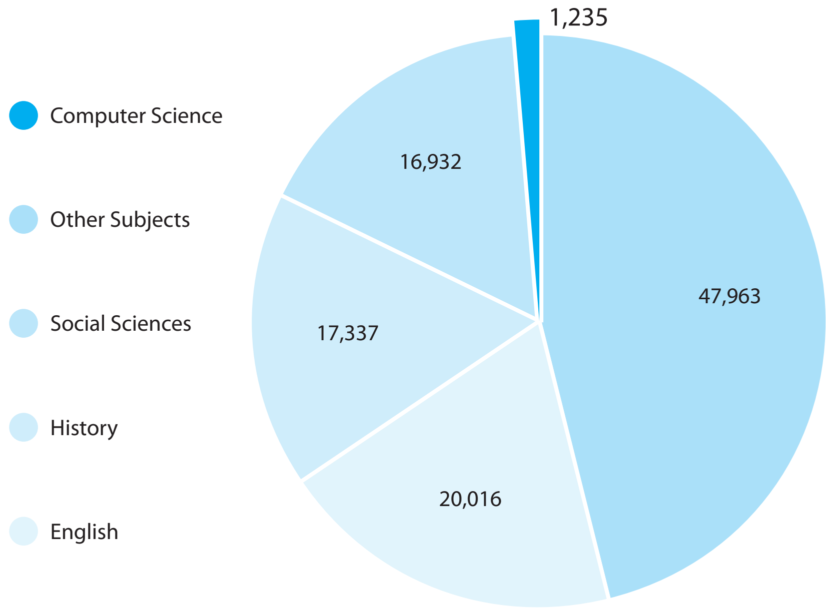
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

New Jersey

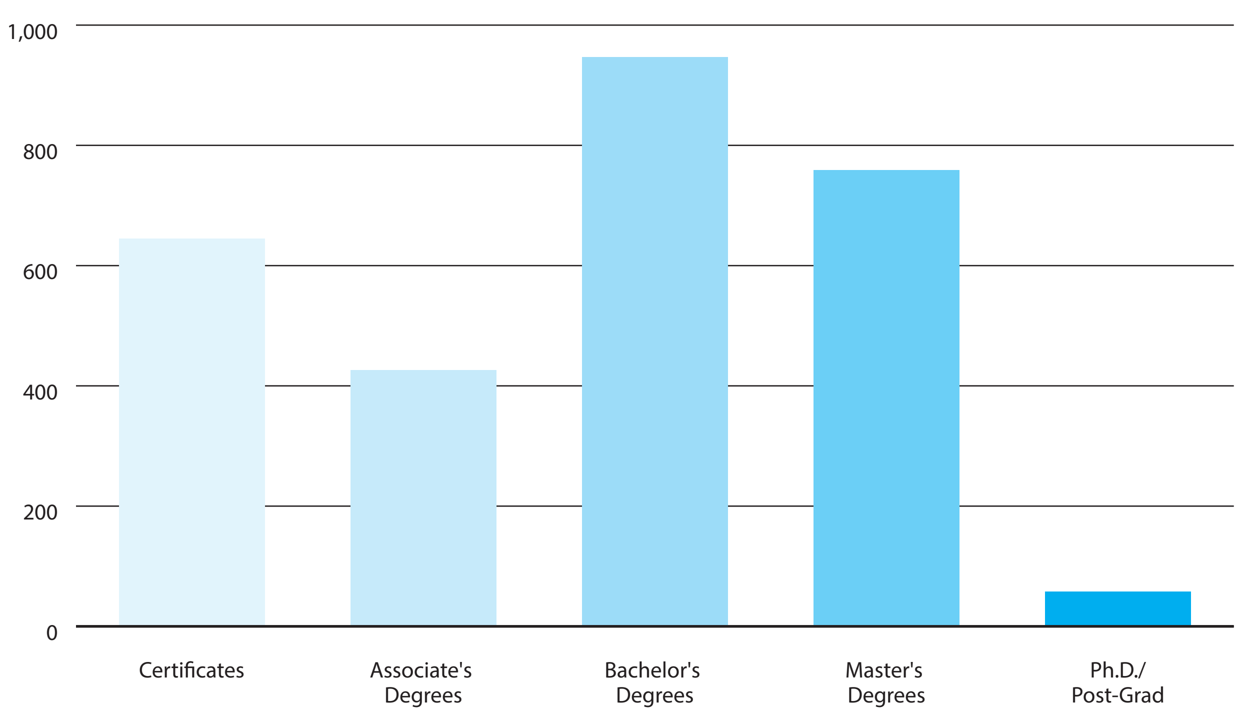
High School Graduation Requirements

New Jersey does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

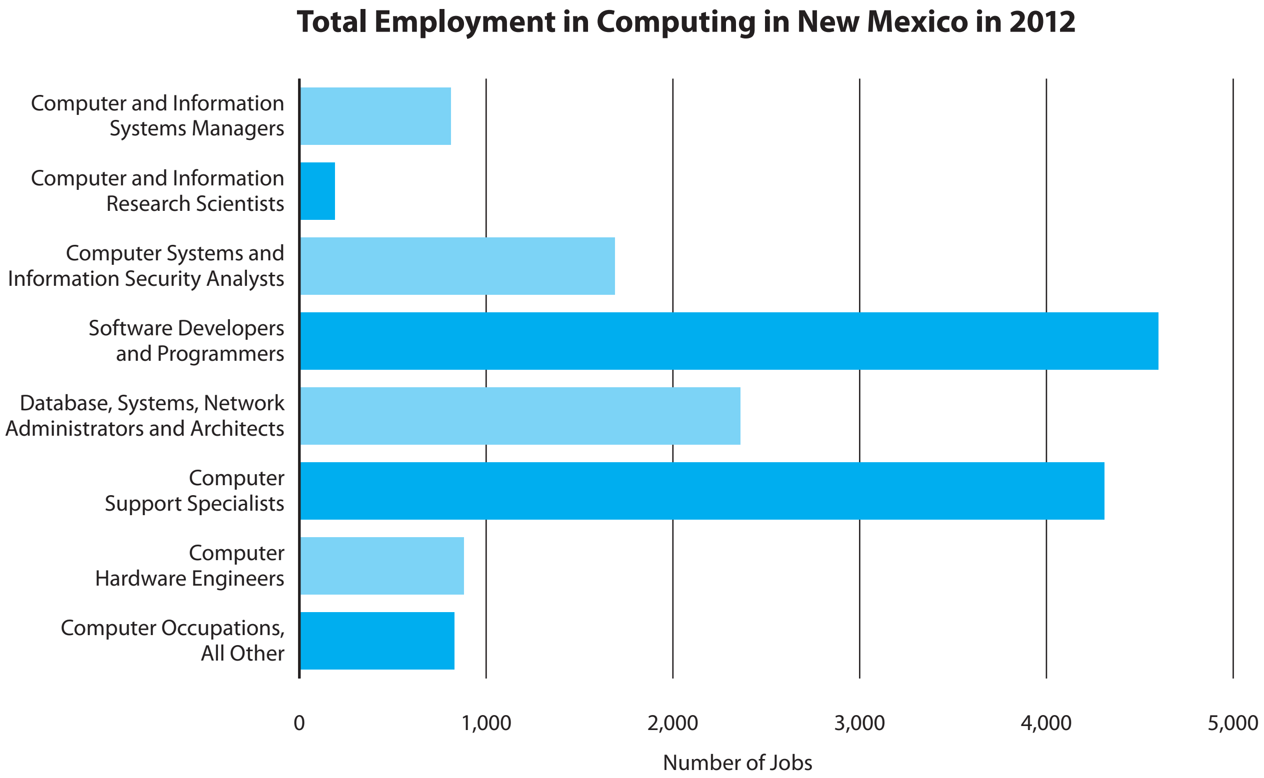
Advanced Placement Exams in New Jersey in 2012

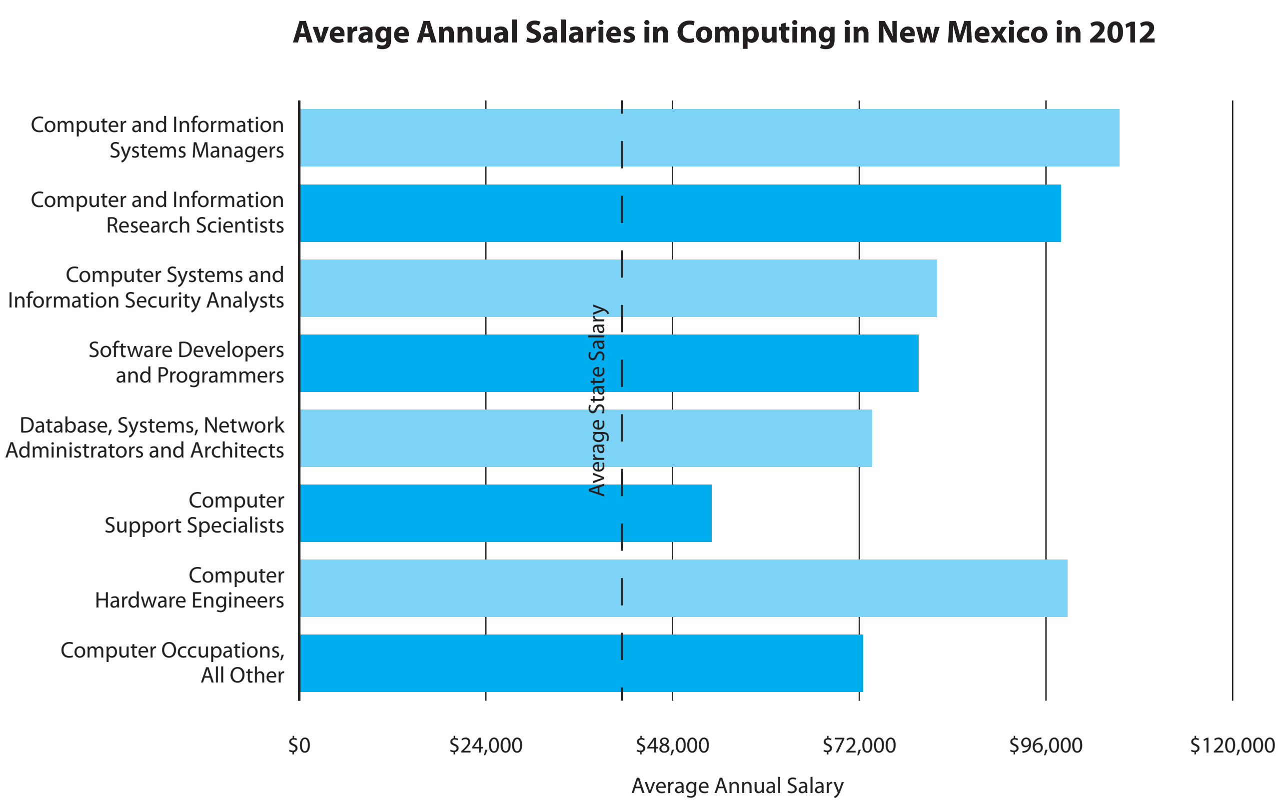


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in New Jersey in 2012



Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).





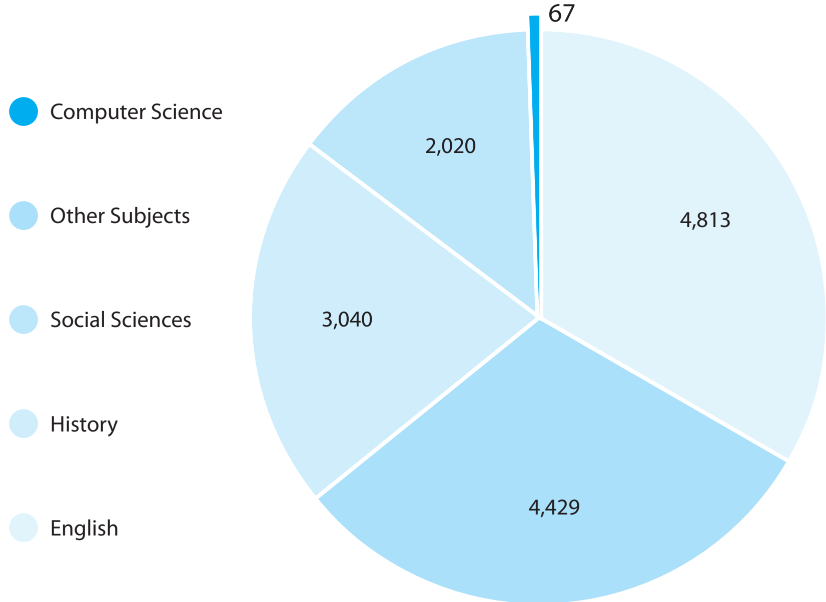
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

New Mexico

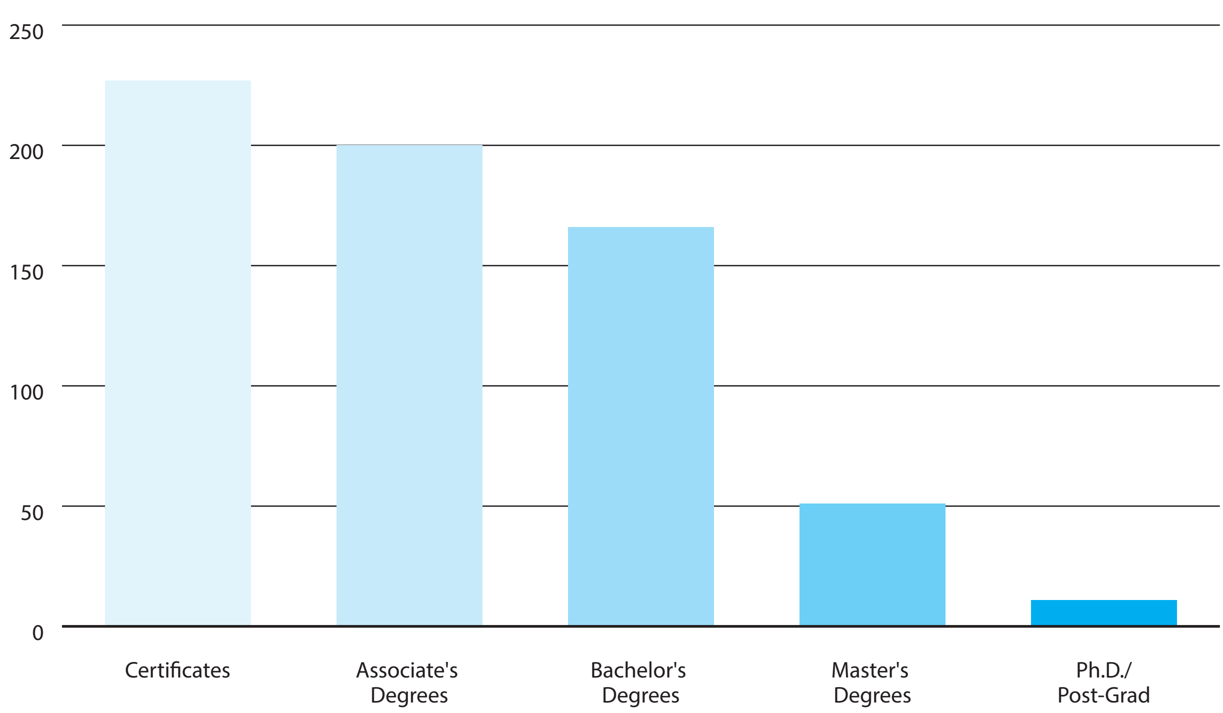
High School Graduation Requirements

New Mexico does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in New Mexico in 2012

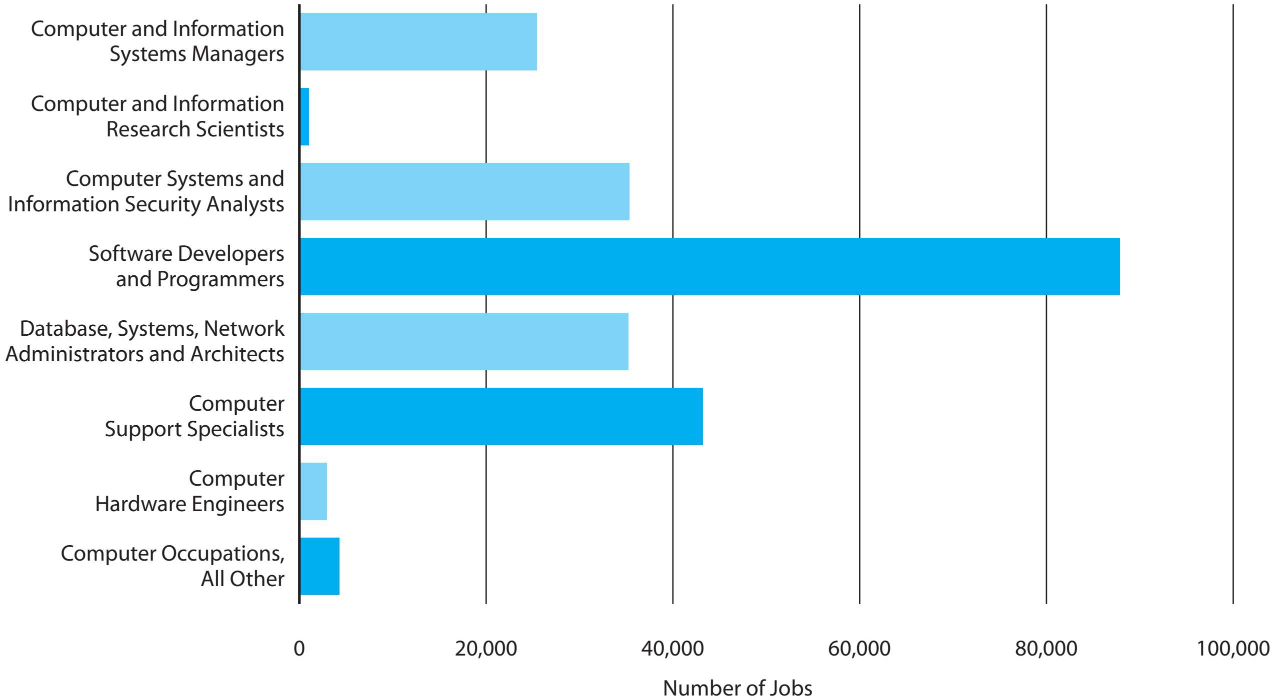


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in New Mexico in 2012

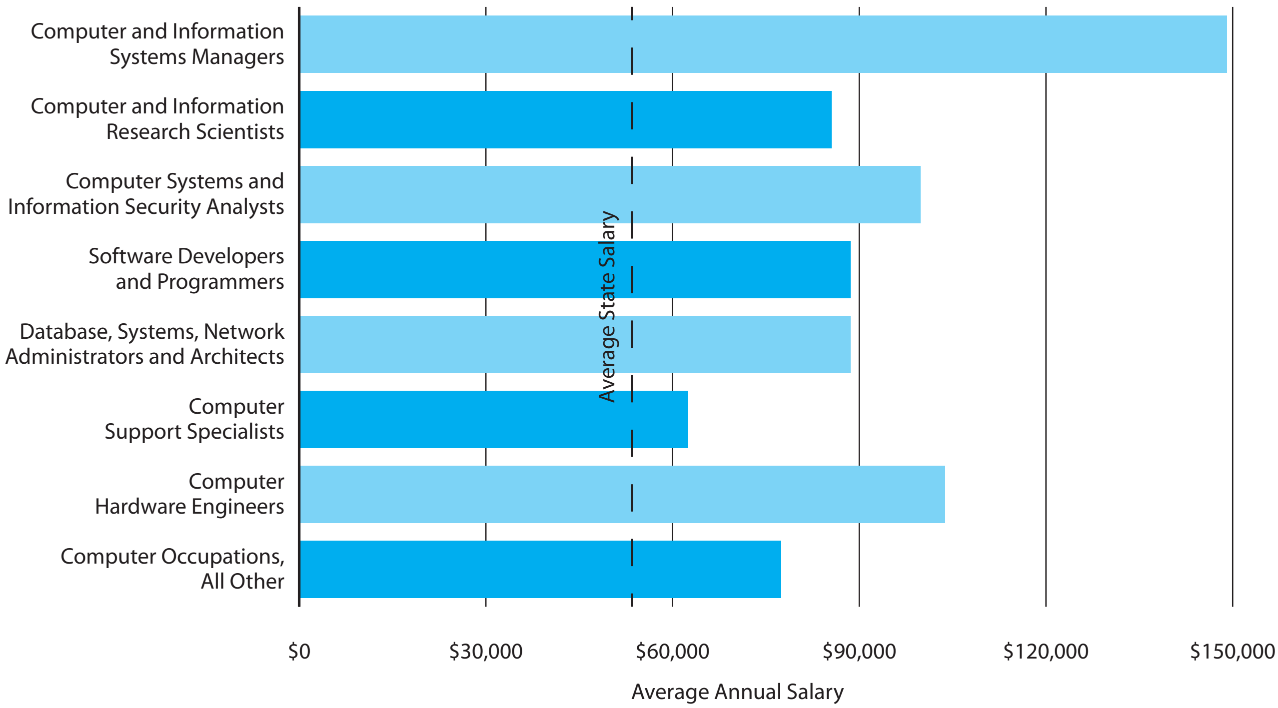


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in New York in 2012



Average Annual Salaries in Computing in New York in 2012



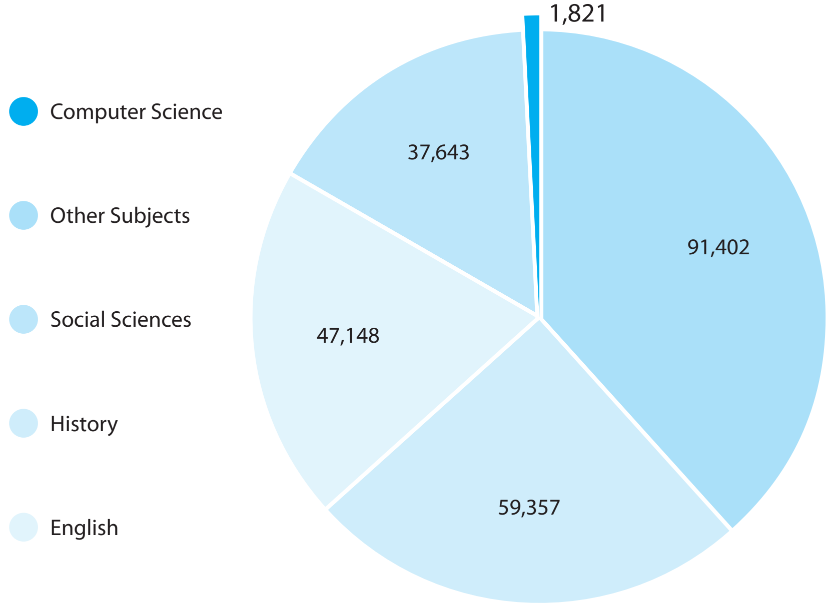
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

New York

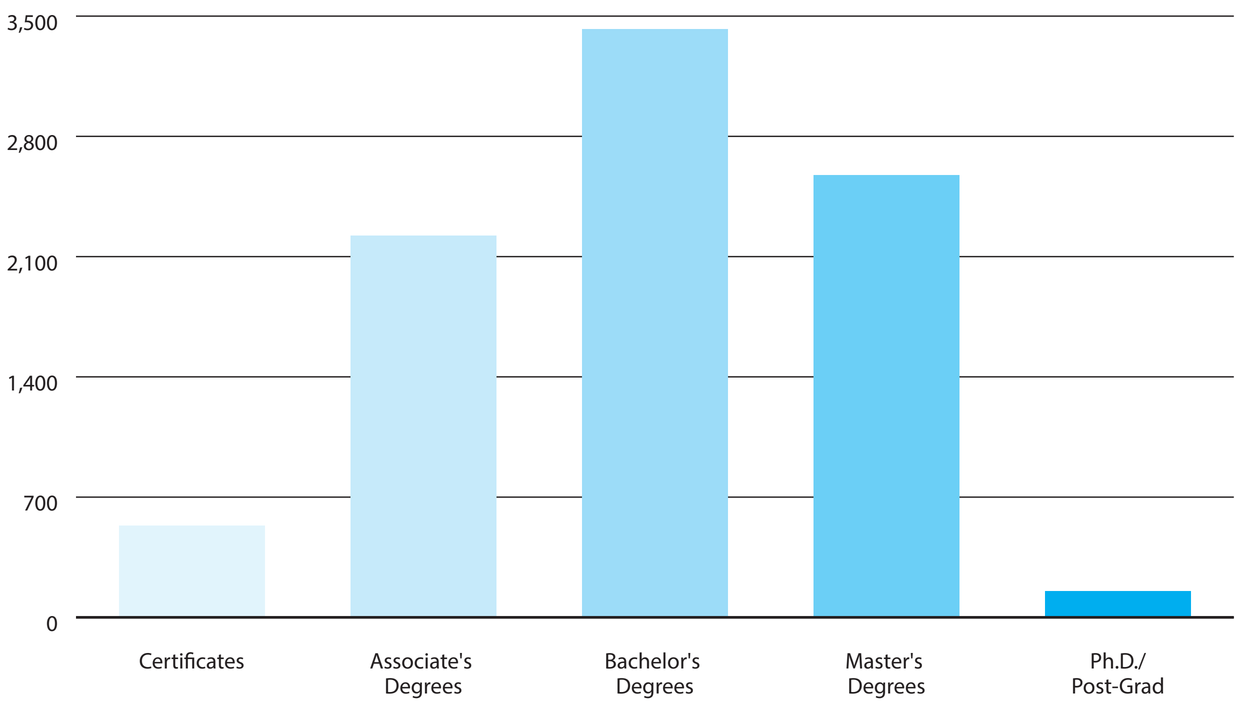
High School Graduation Requirements

New York clearly allows computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in New York in 2012

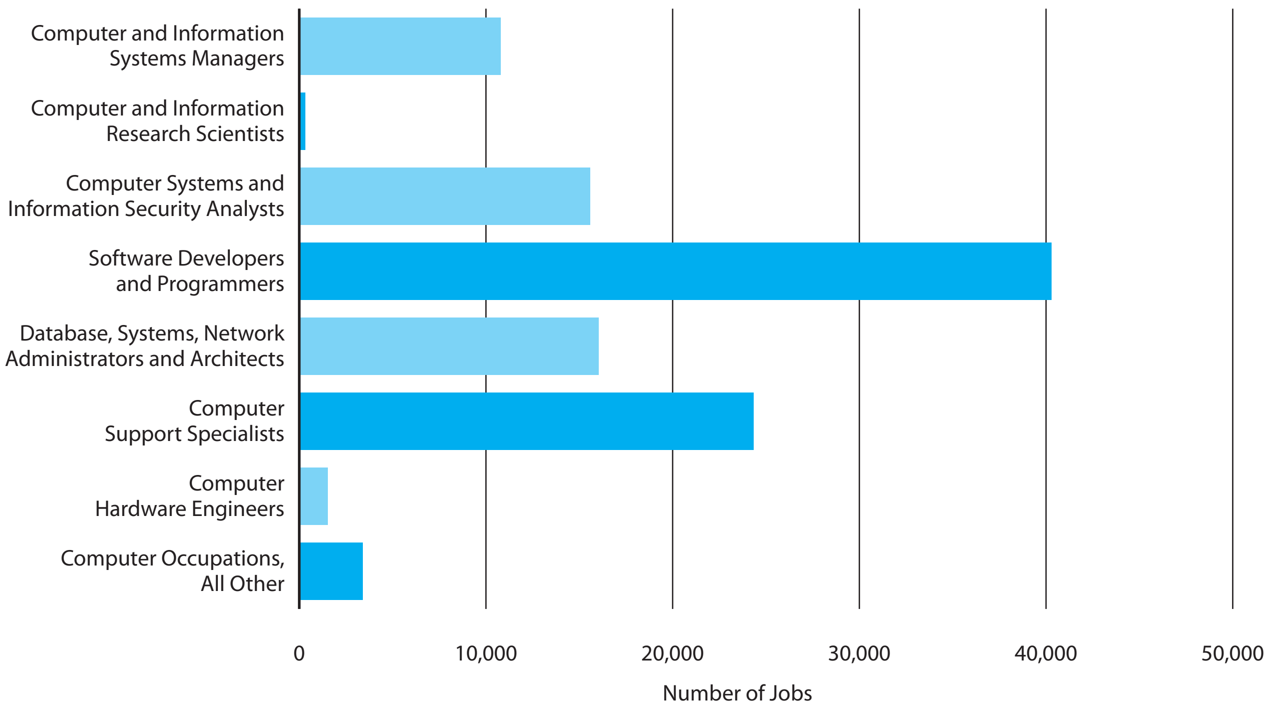


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in New York in 2012

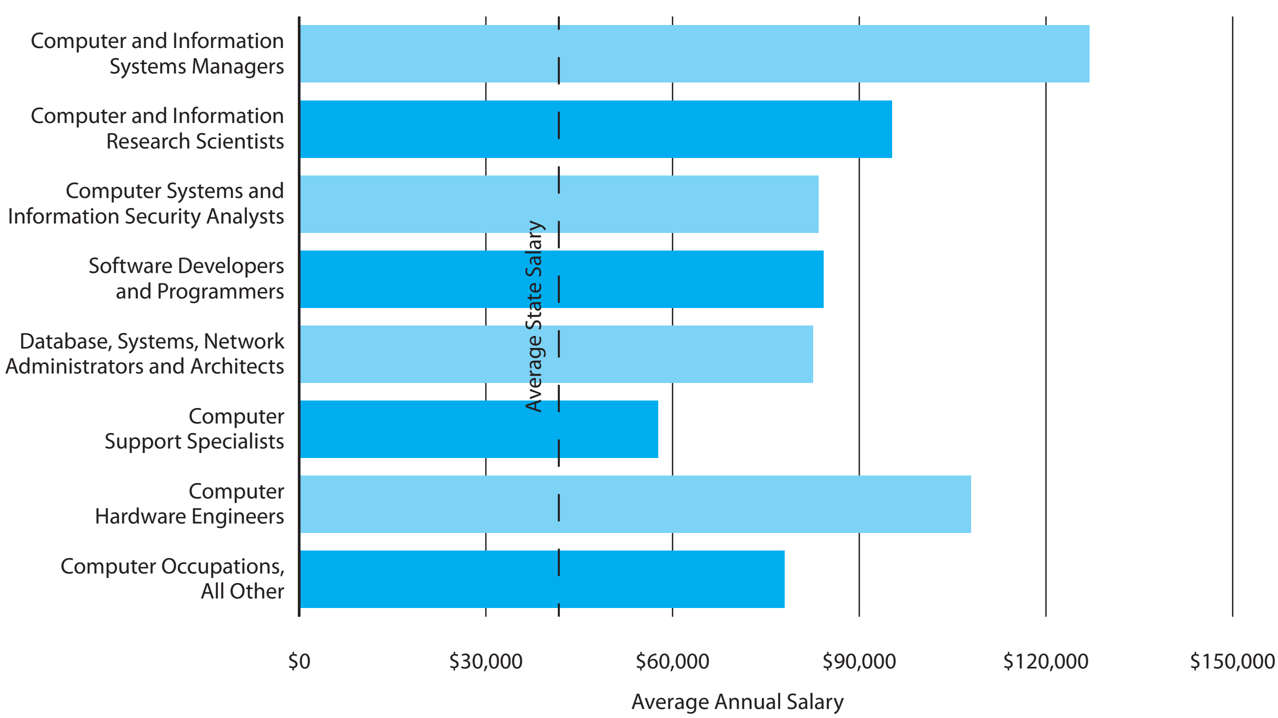


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in North Carolina in 2012



Average Annual Salaries in Computing in North Carolina in 2012



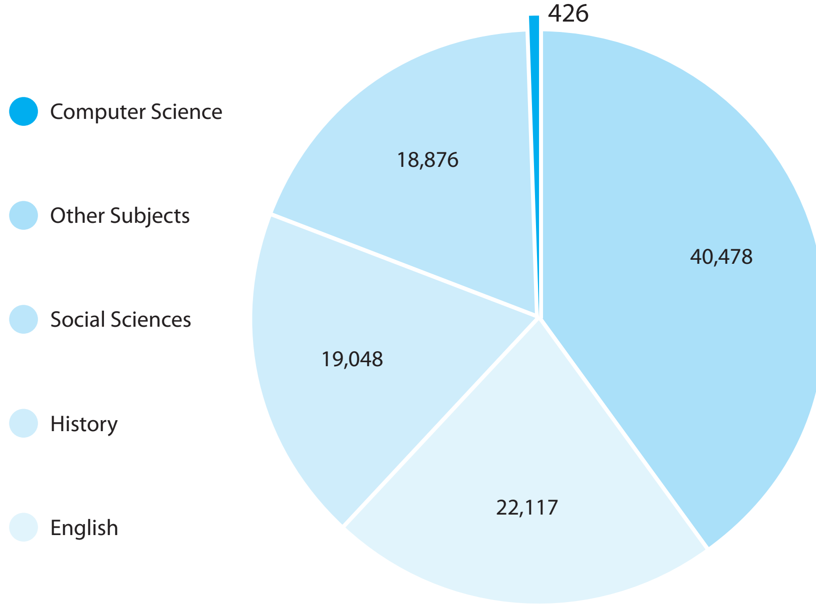
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

North Carolina

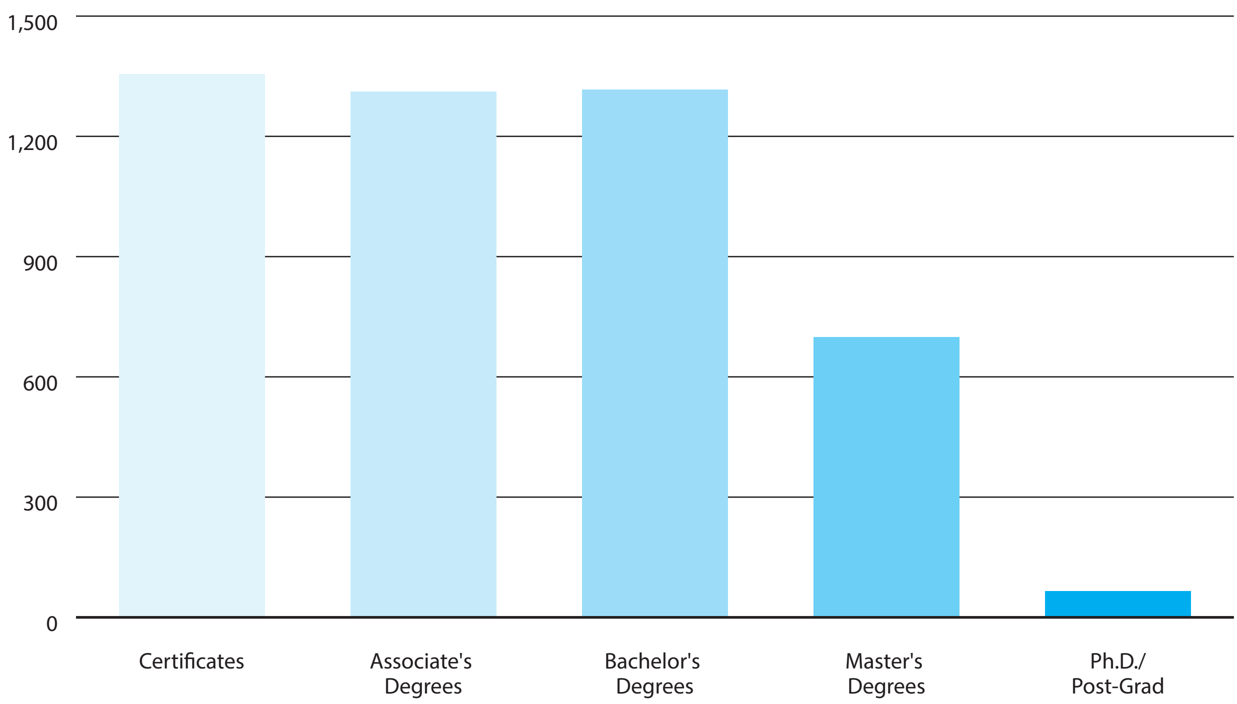
High School Graduation Requirements

North Carolina clearly allows computer science to satisfy a core high school graduation requirement in mathematics.

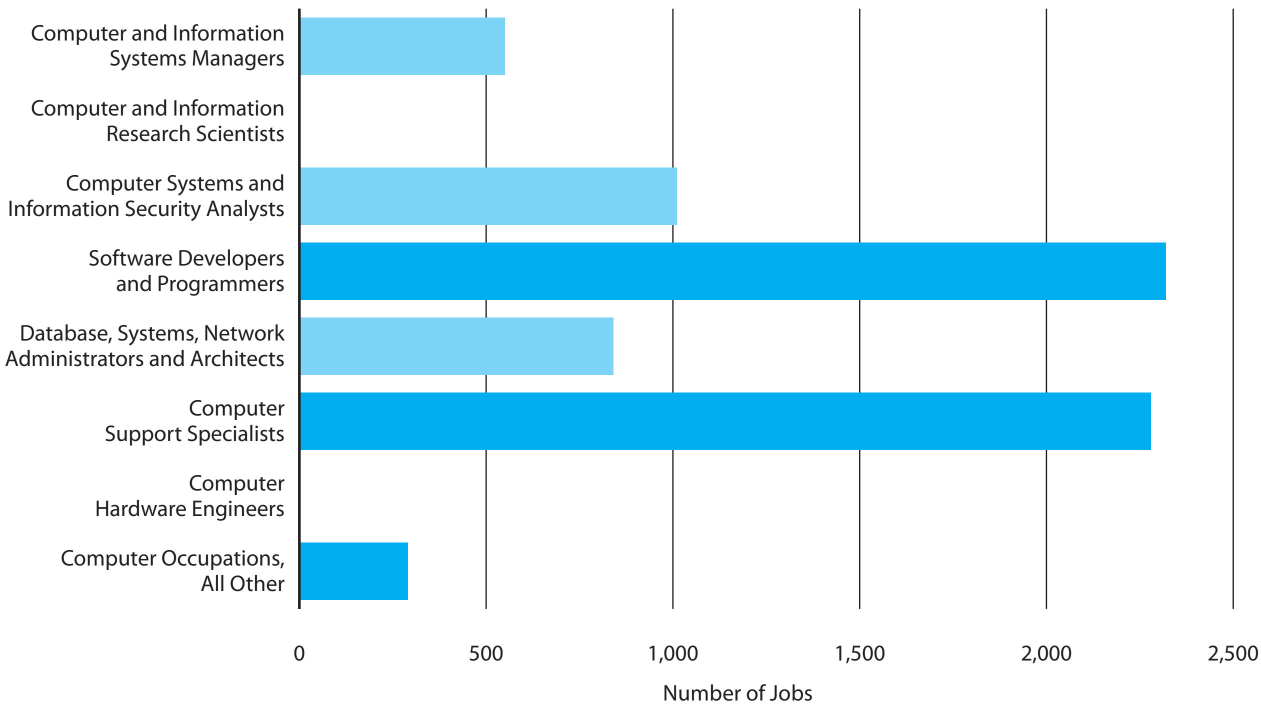
Advanced Placement Exams in North Carolina in 2012

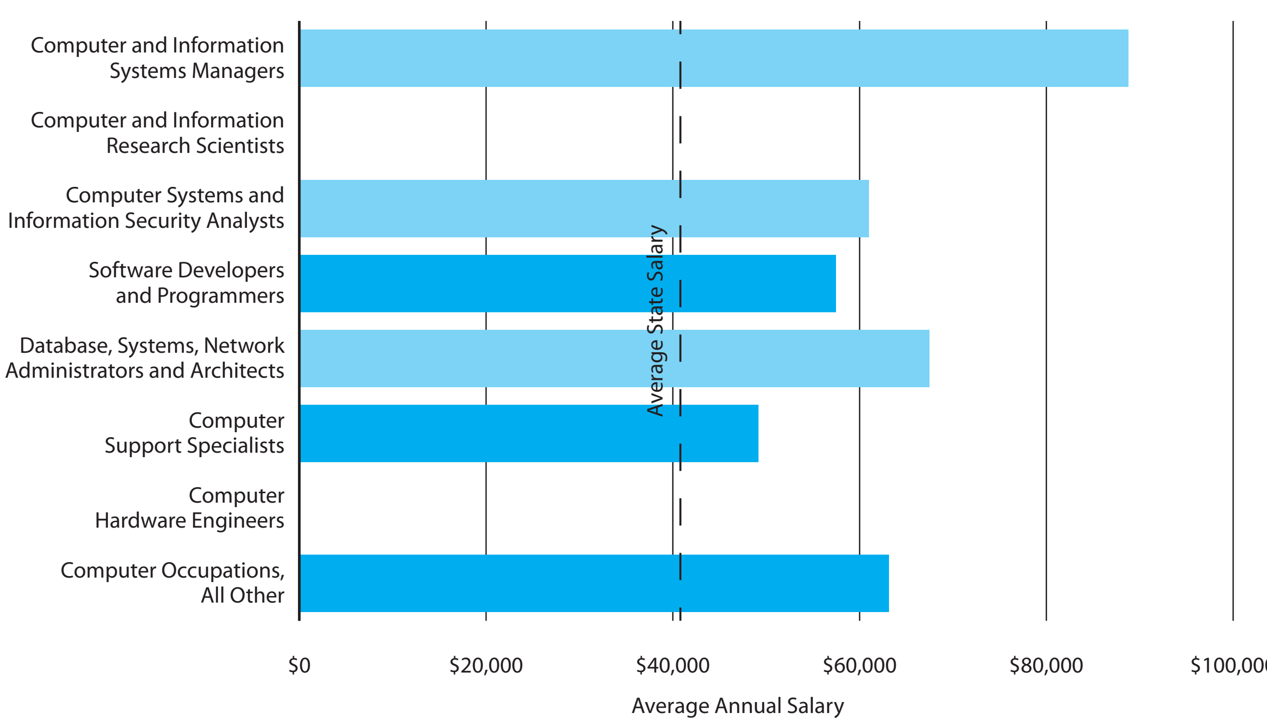


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in North Carolina in 2012



Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).





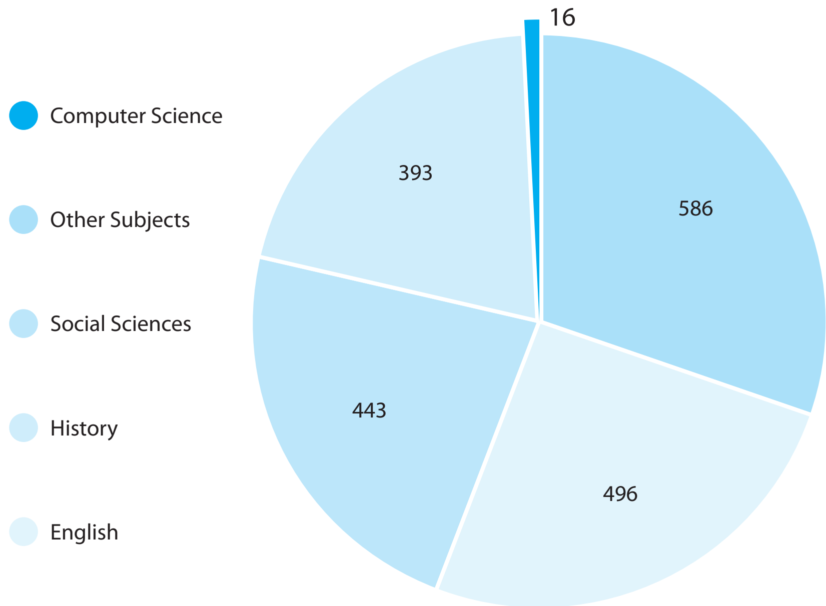
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

North Dakota

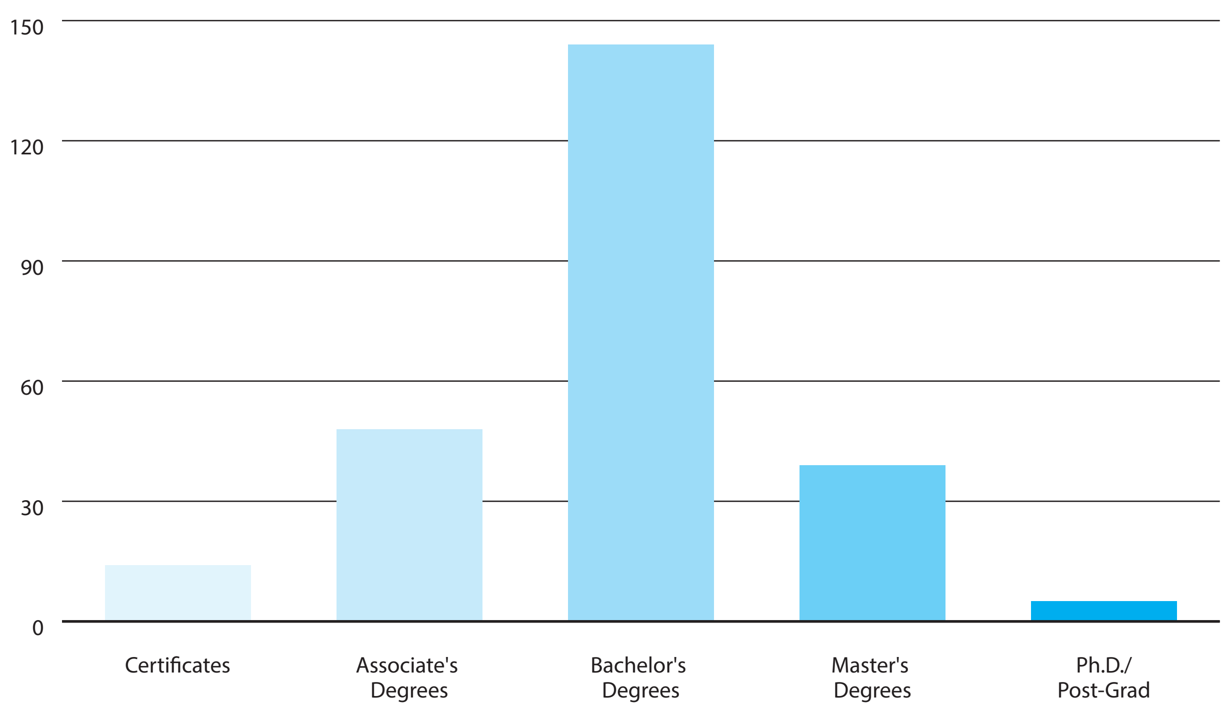
High School Graduation Requirements

North Dakota does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in North Dakota in 2012

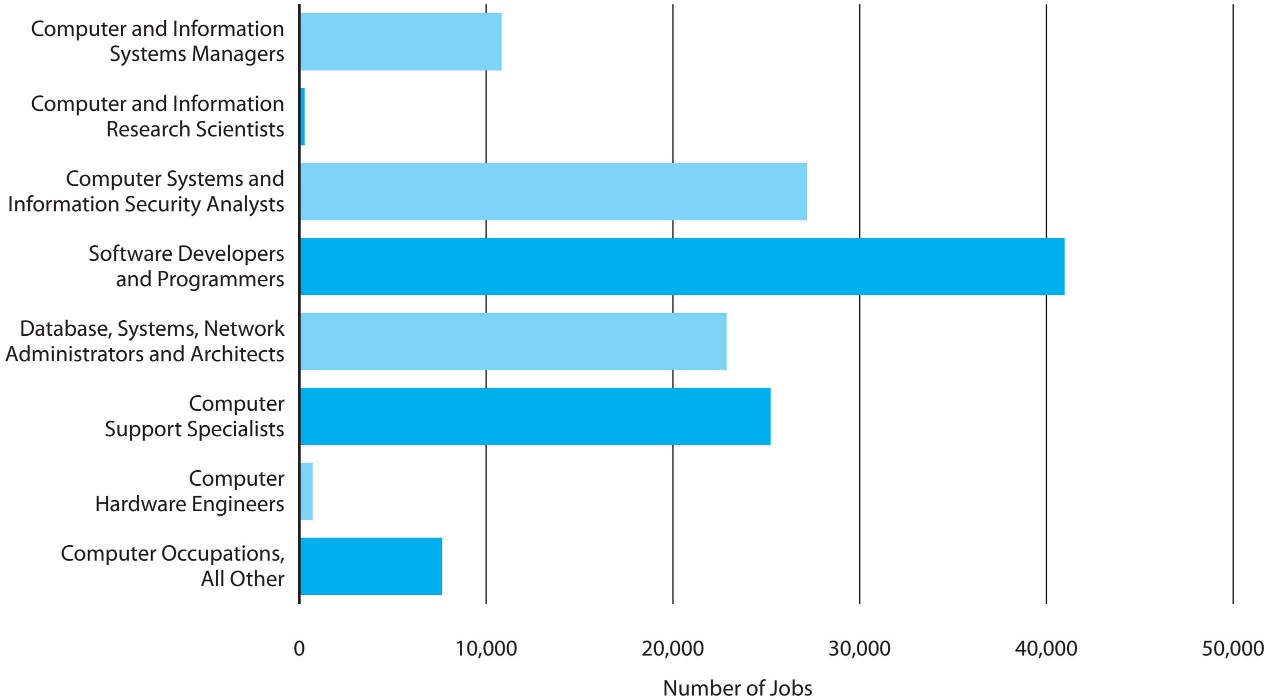


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in North Dakota in 2012

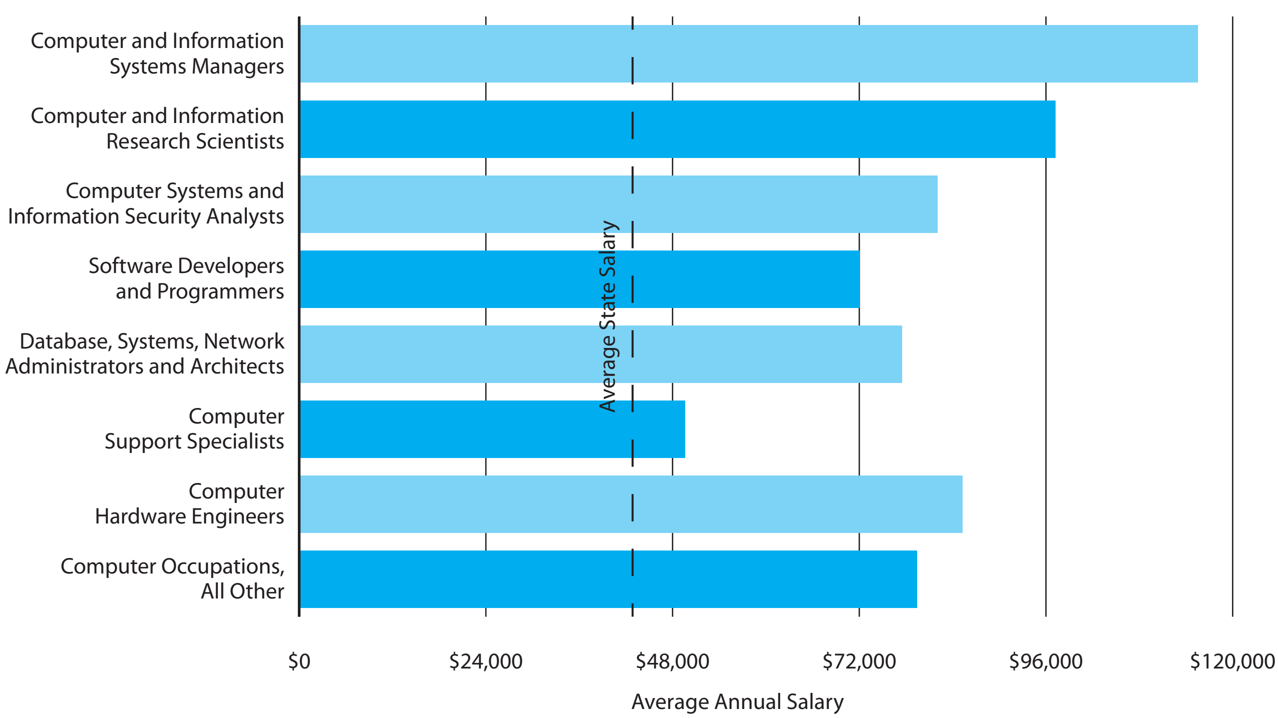


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Ohio in 2012



Average Annual Salaries in Computing in Ohio in 2012



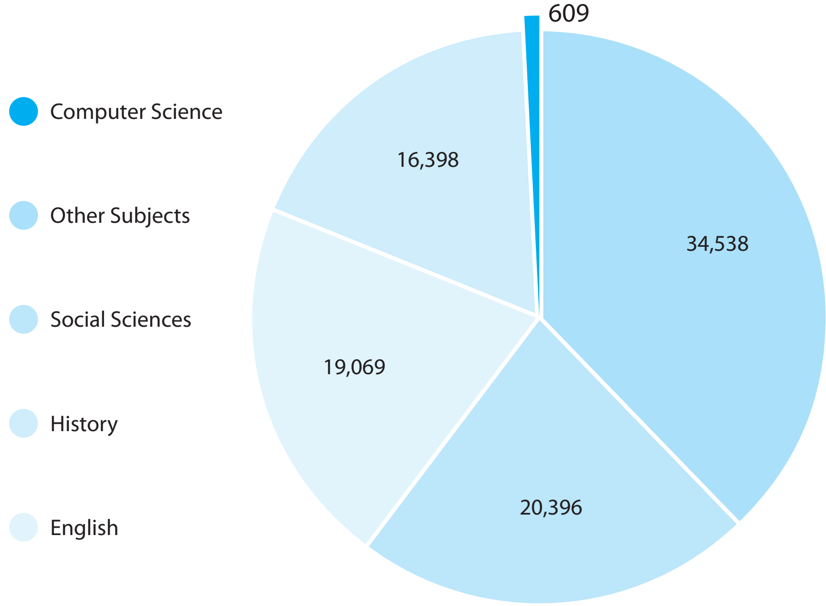
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Ohio

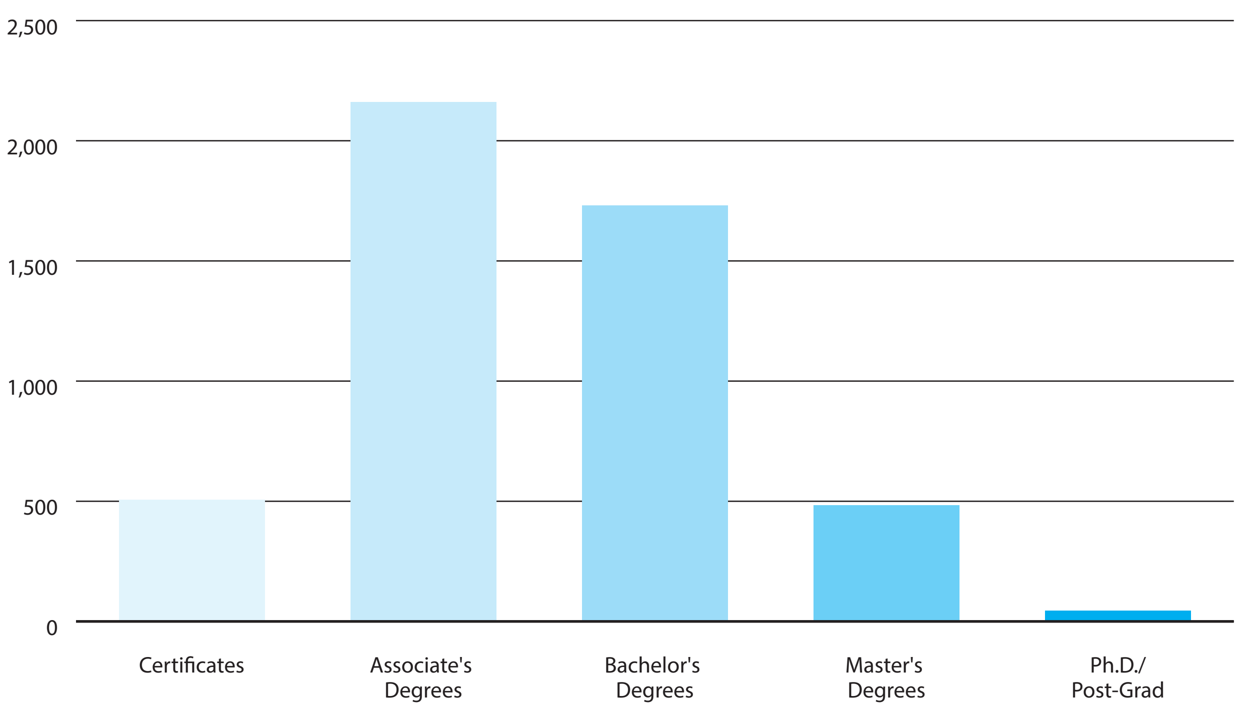
High School Graduation Requirements

Ohio does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Ohio in 2012

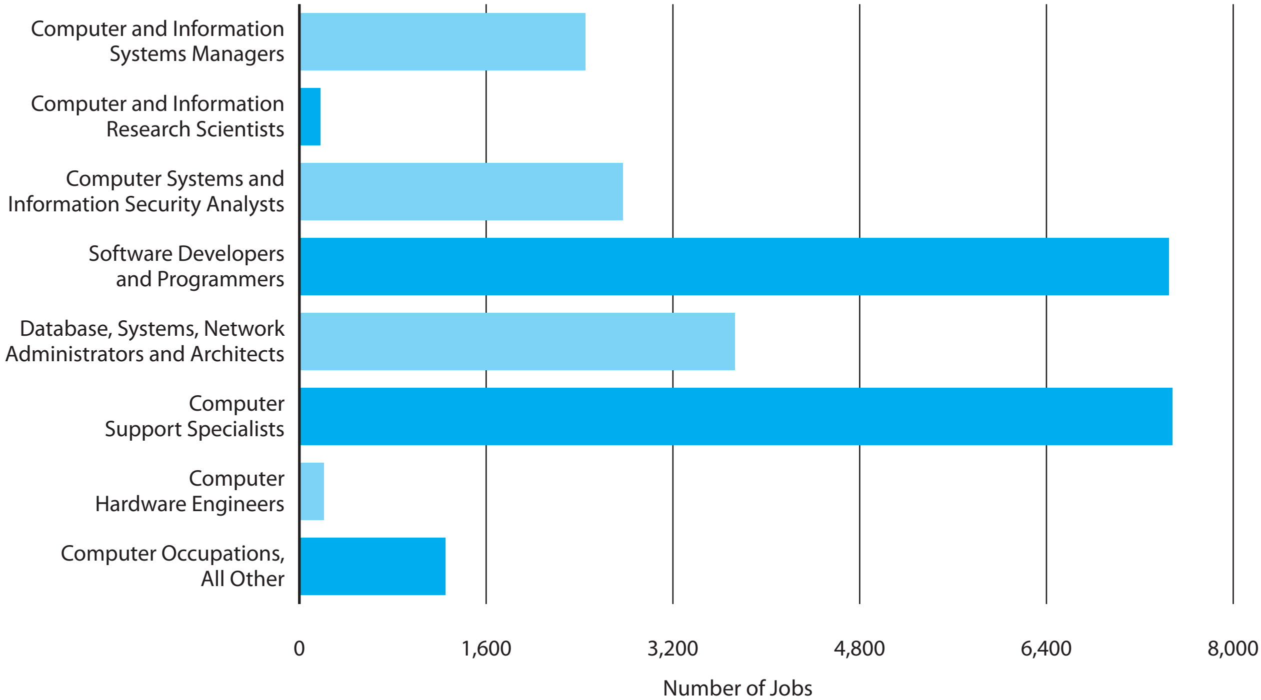


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Ohio in 2012

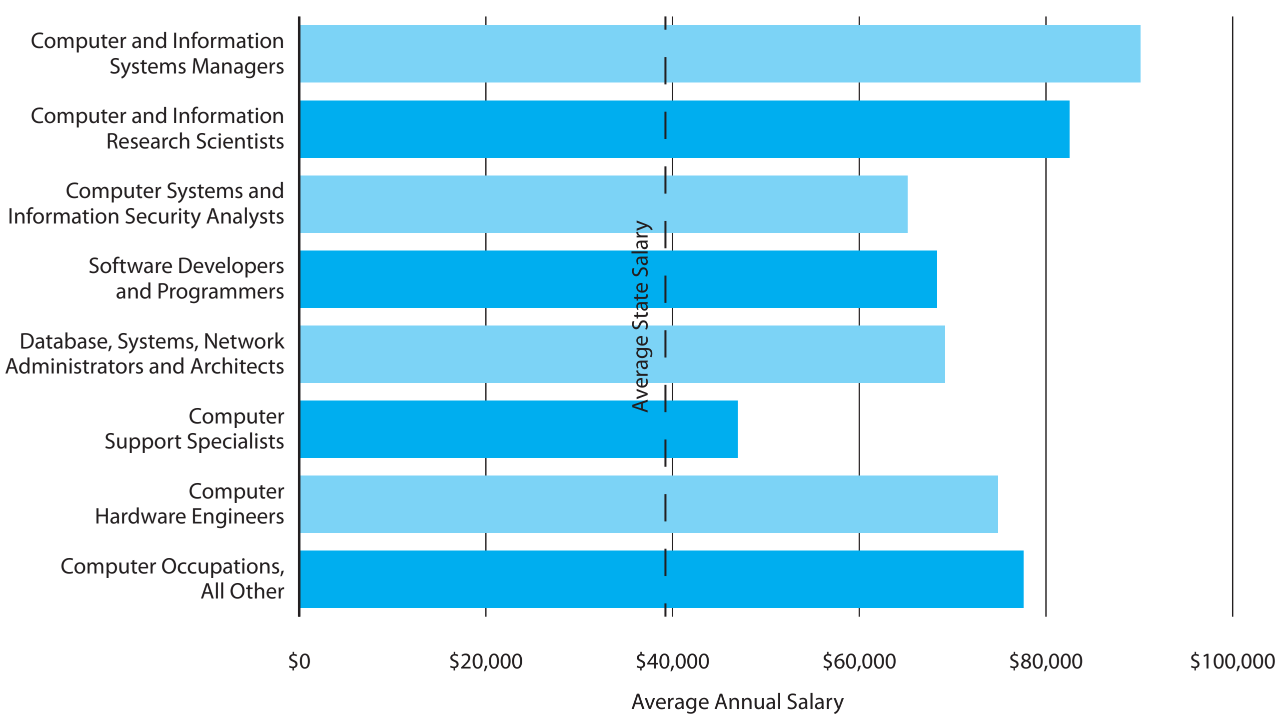


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Oklahoma in 2012



Average Annual Salaries in Computing in Oklahoma in 2012



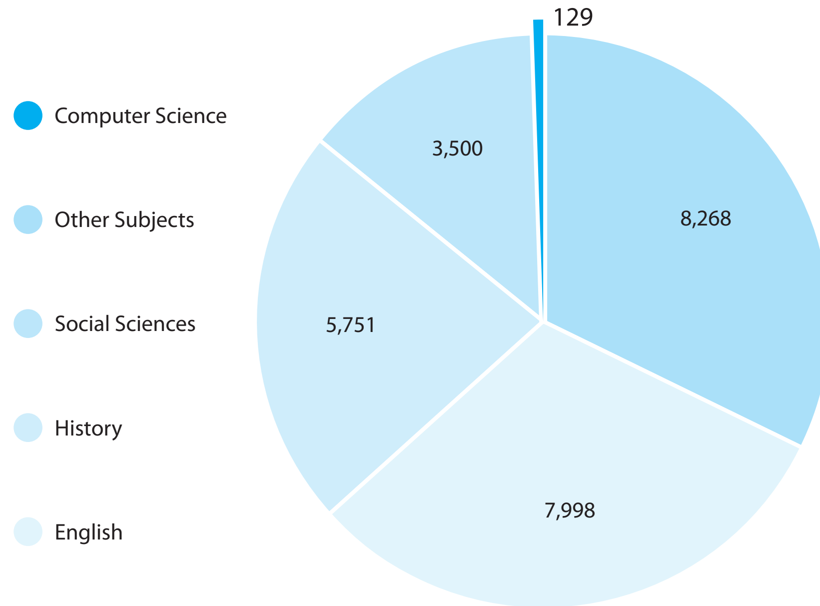
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Oklahoma

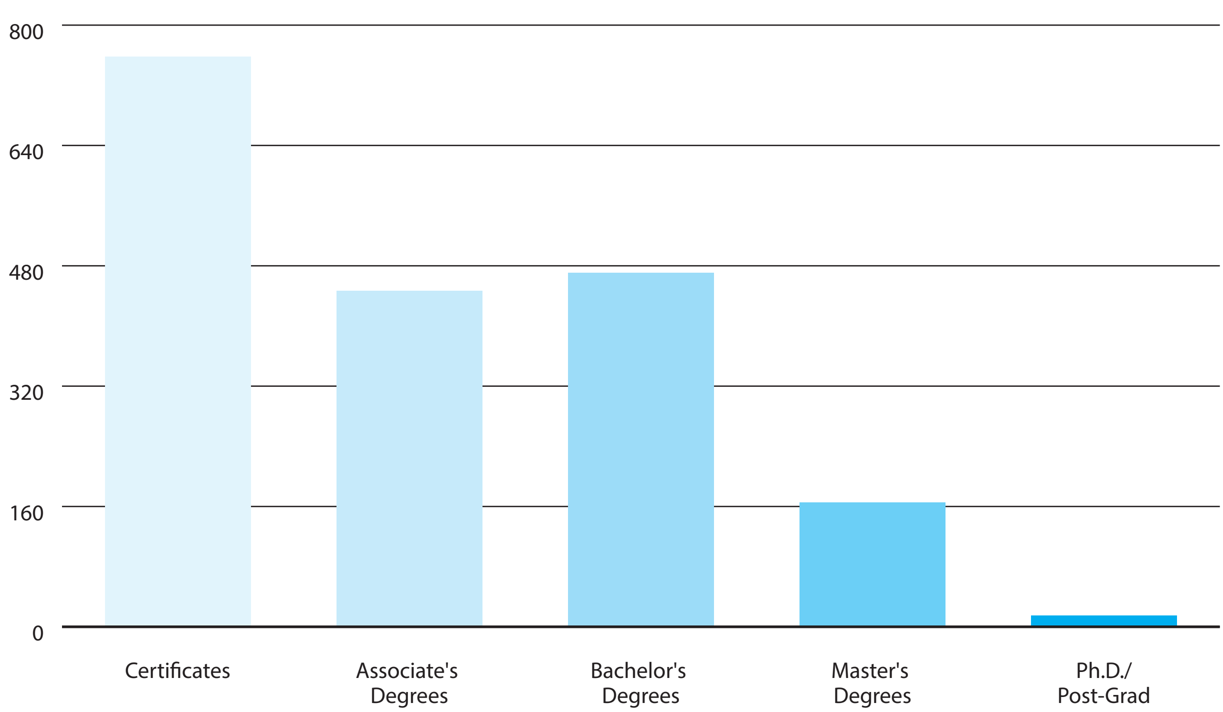
High School Graduation Requirements

Oklahoma clearly allows computer science to satisfy a core high school graduation requirement in mathematics.

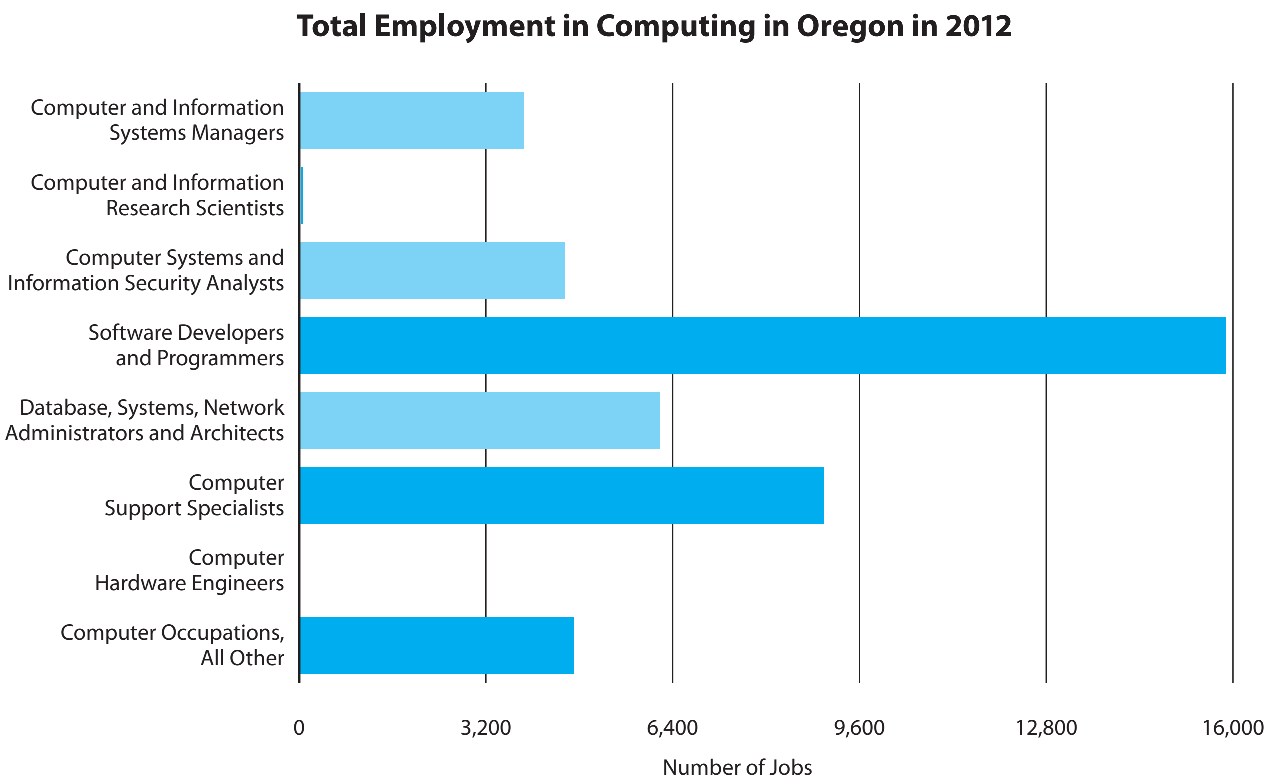
Advanced Placement Exams in Oklahoma in 2012

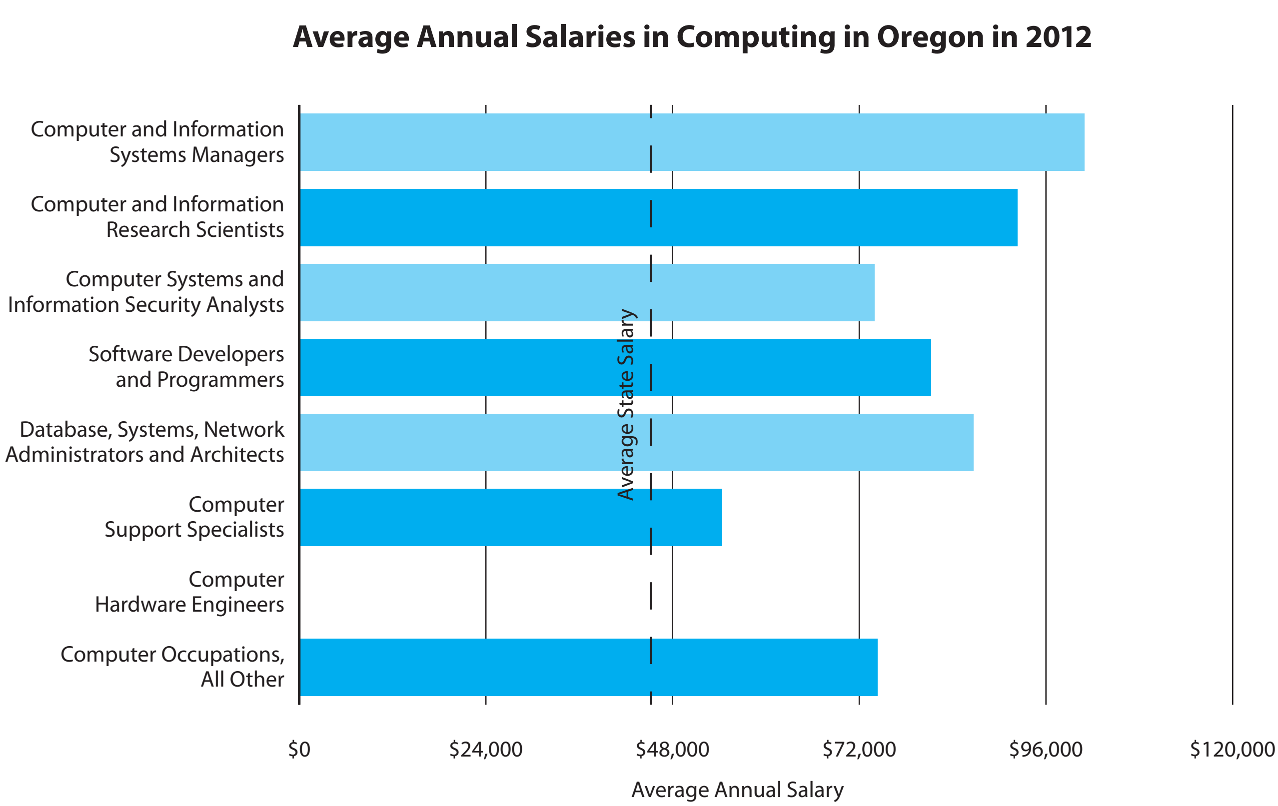


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Oklahoma in 2012



Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).





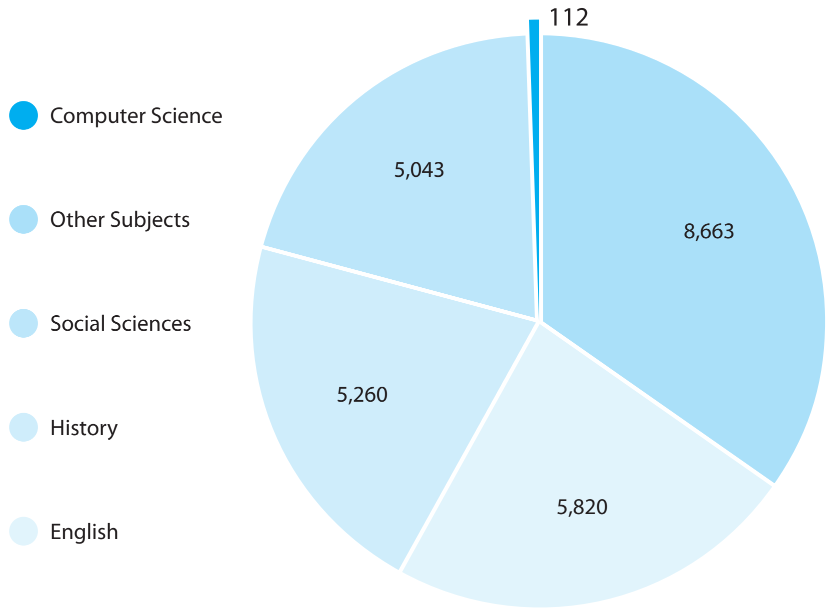
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Oregon

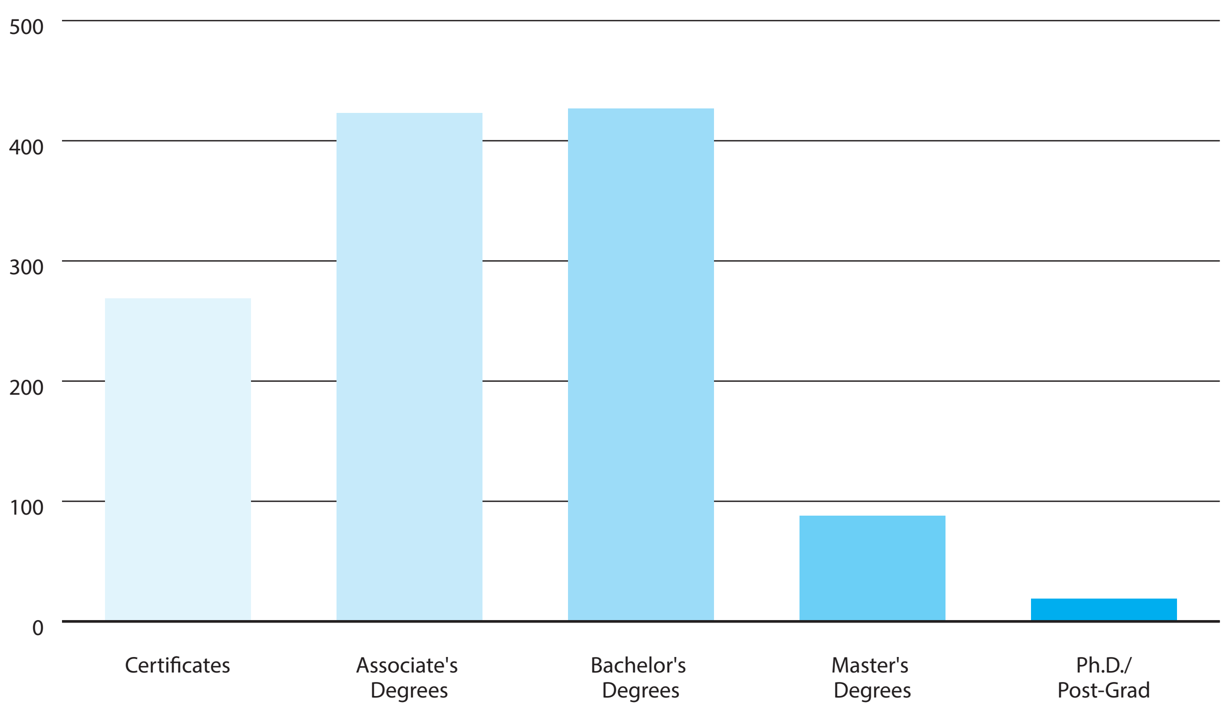
High School Graduation Requirements

Oregon clearly allows computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Oregon in 2012

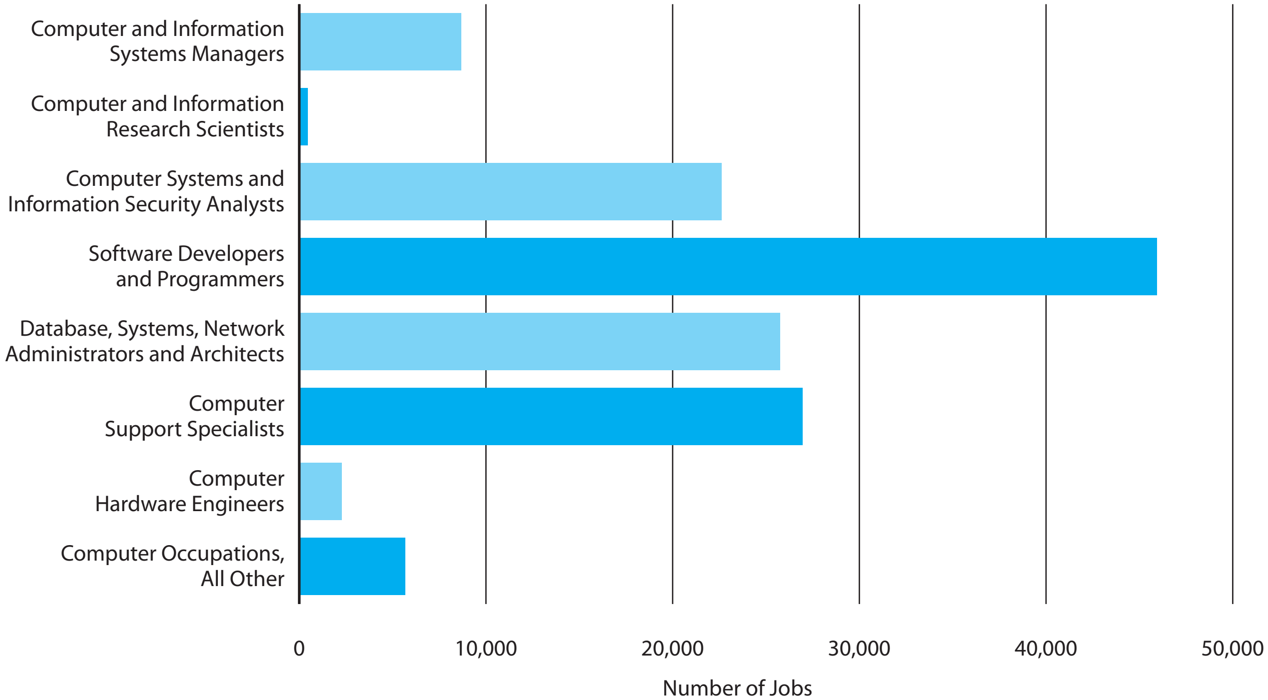


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Oregon in 2012

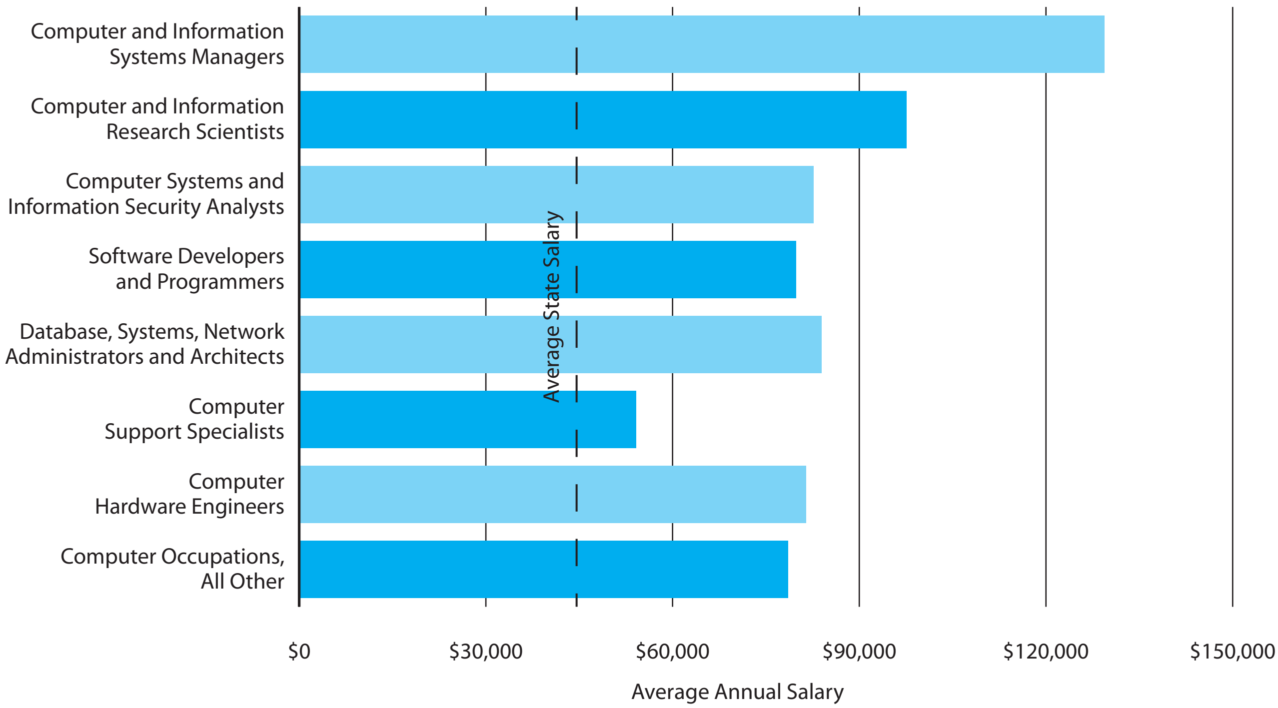


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Pennsylvania in 2012



Average Annual Salaries in Computing in Pennsylvania in 2012



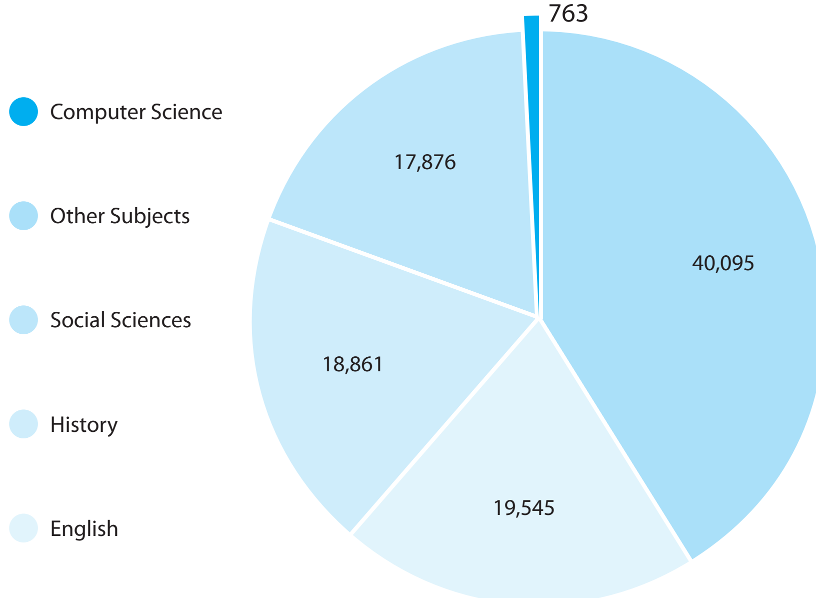
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Pennsylvania

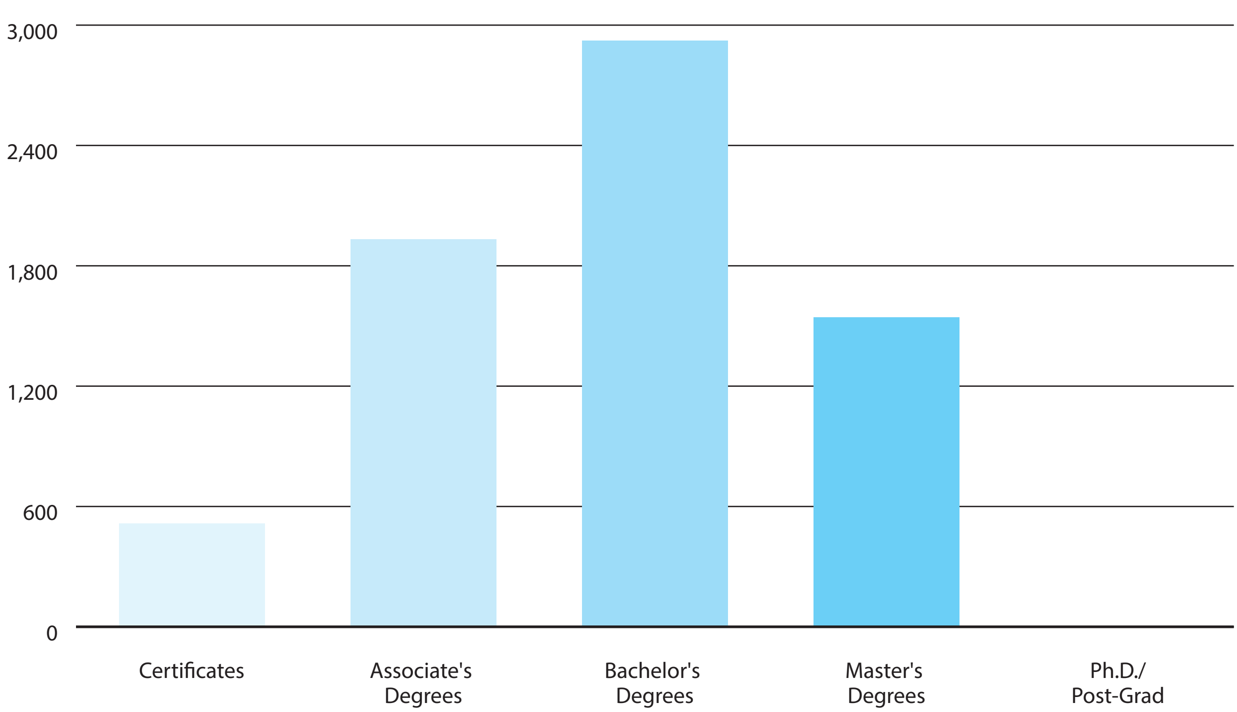
High School Graduation Requirements

Pennsylvania does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Pennsylvania in 2012



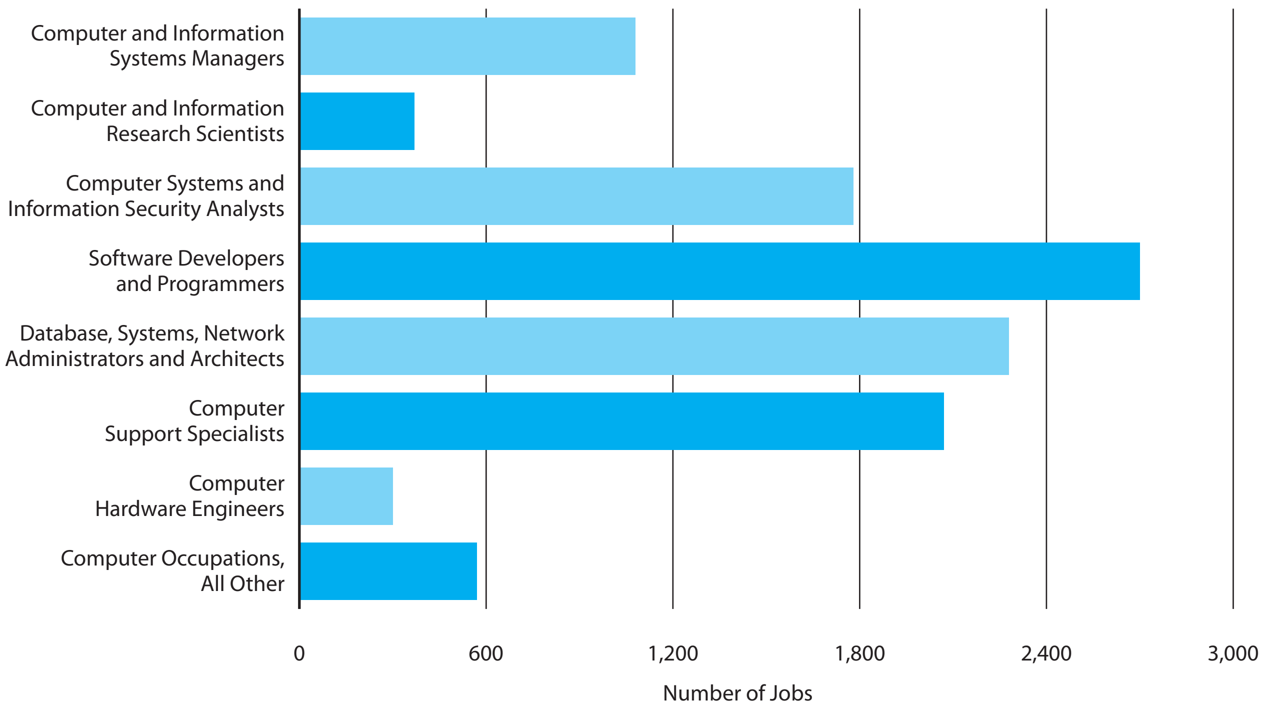
Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Pennsylvania in 2012



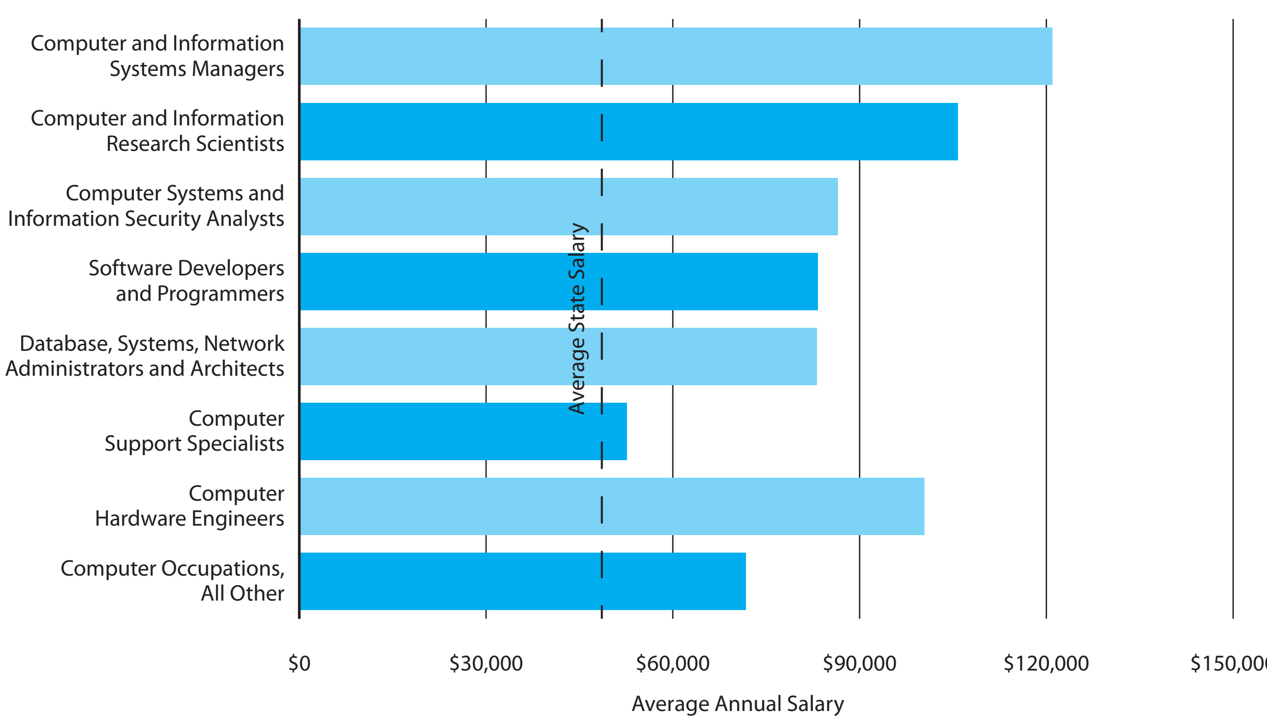
Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Rhode Island

Total Employment in Computing in Rhode Island in 2012



Average Annual Salaries in Computing in Rhode Island in 2012



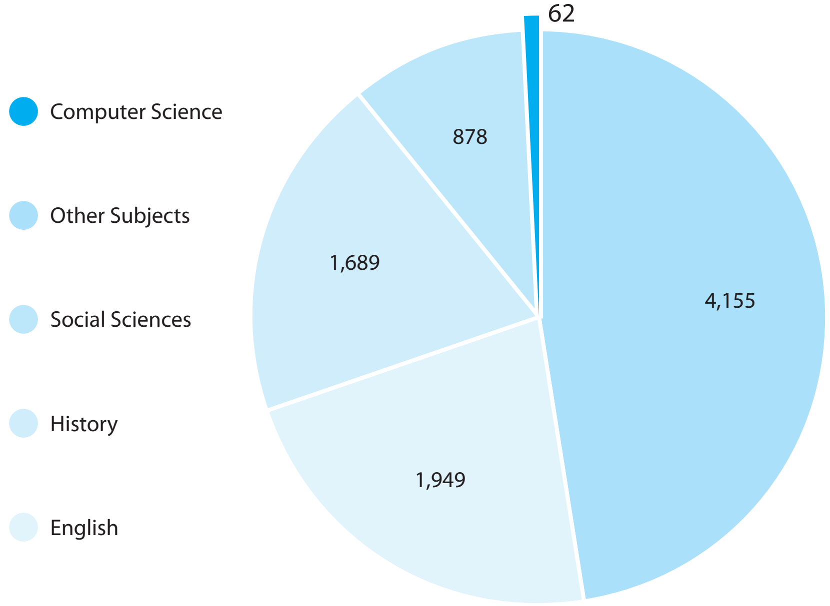
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Rhode Island

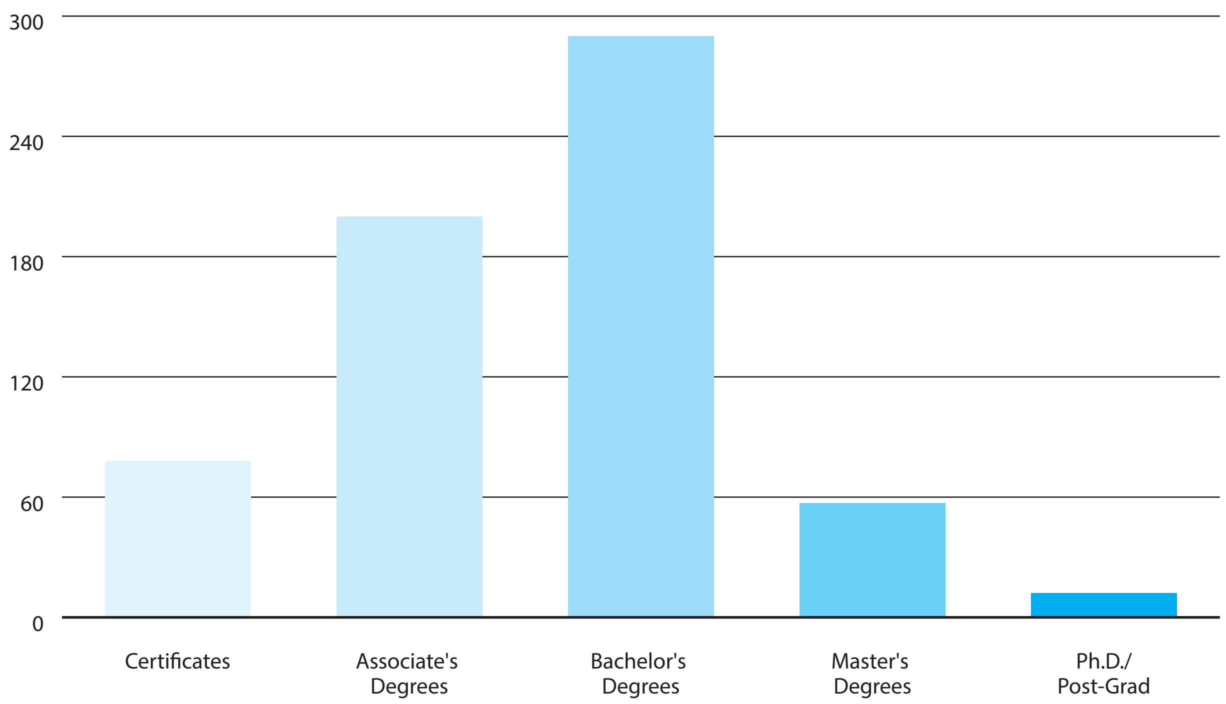
High School Graduation Requirements

Rhode Island clearly allows computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Rhode Island in 2012

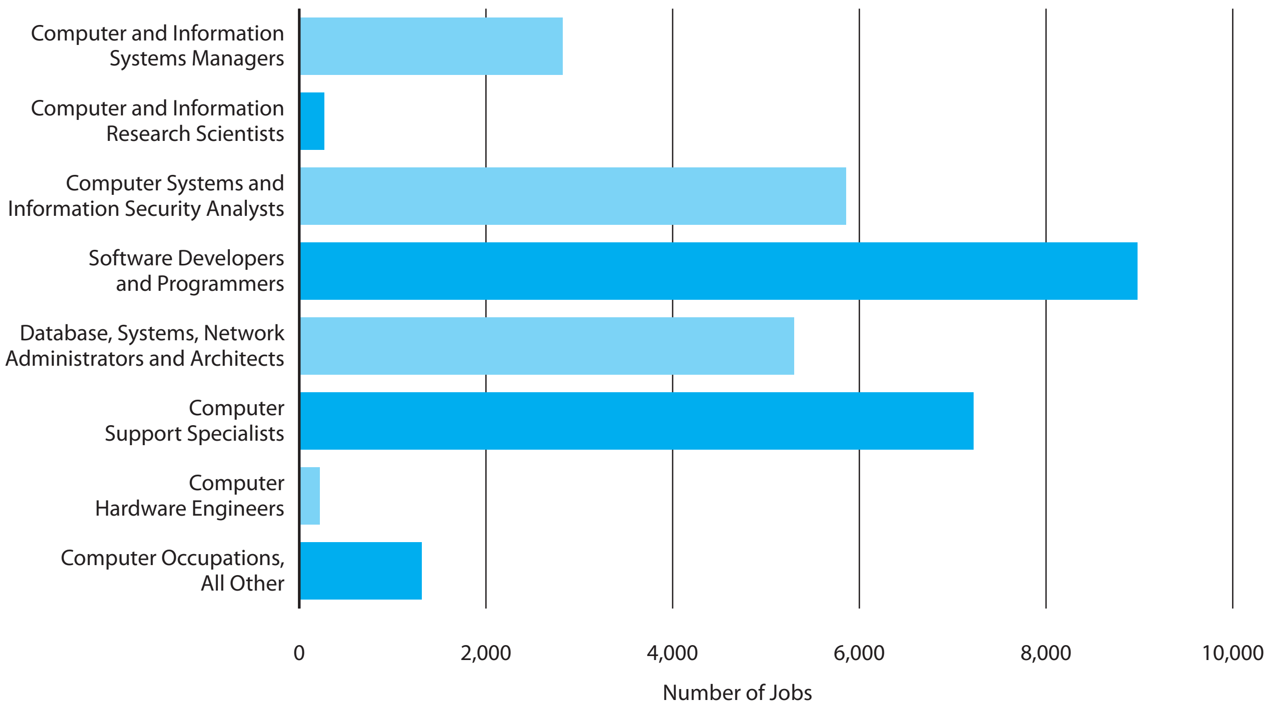


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Rhode Island in 2012

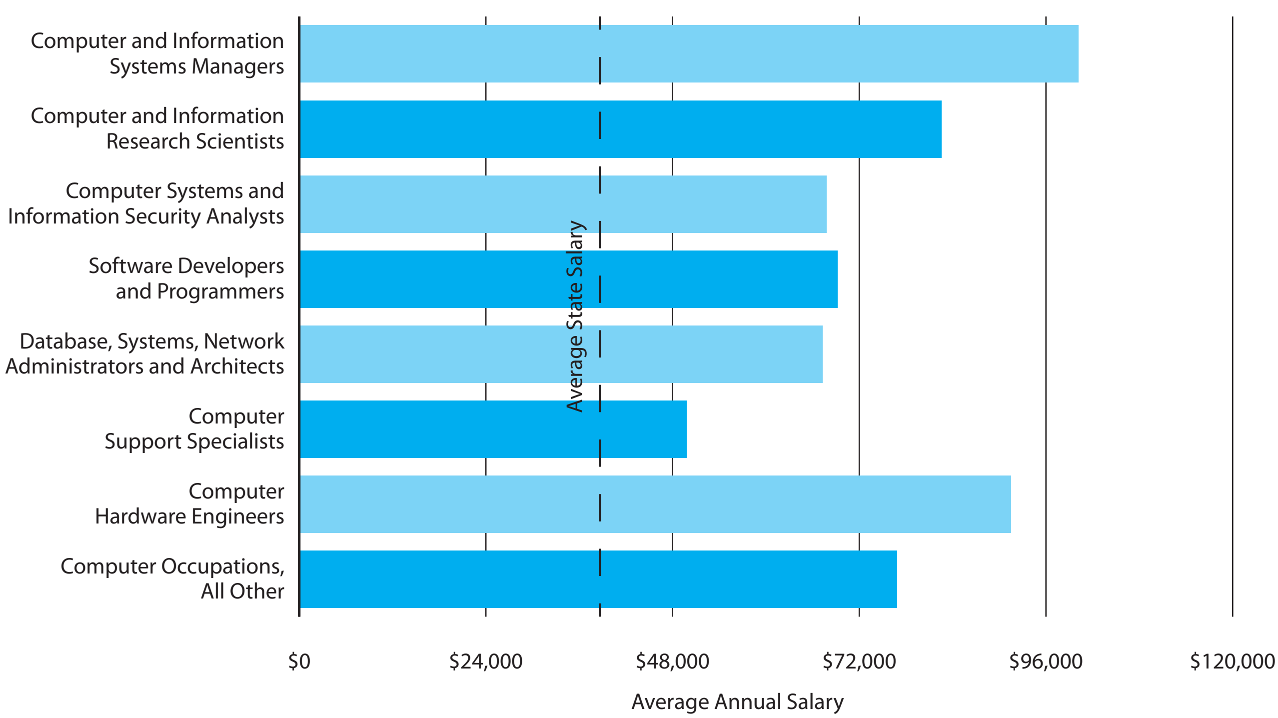


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in South Carolina in 2012



Average Annual Salaries in Computing in South Carolina in 2012



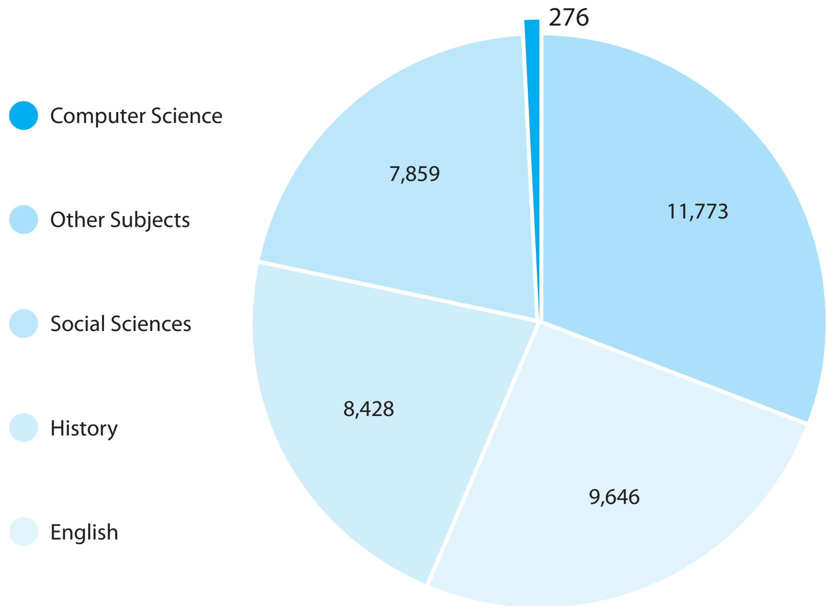
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

South Carolina

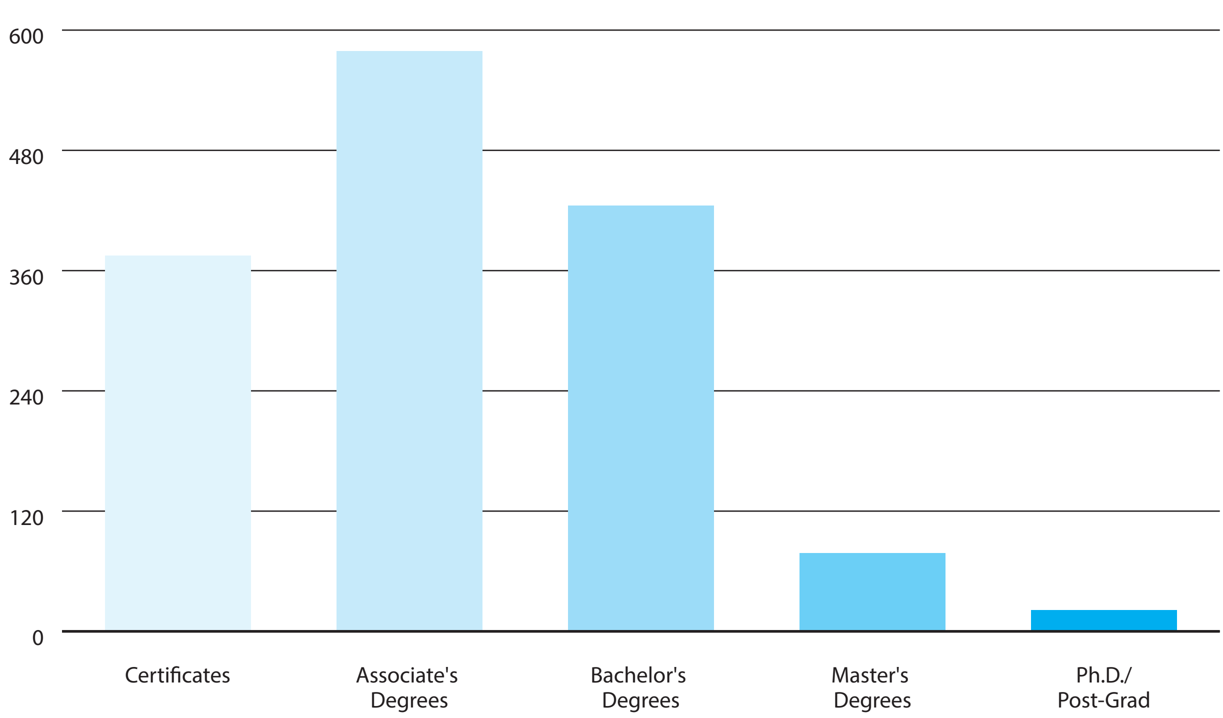
High School Graduation Requirements

South Carolina does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in South Carolina in 2012

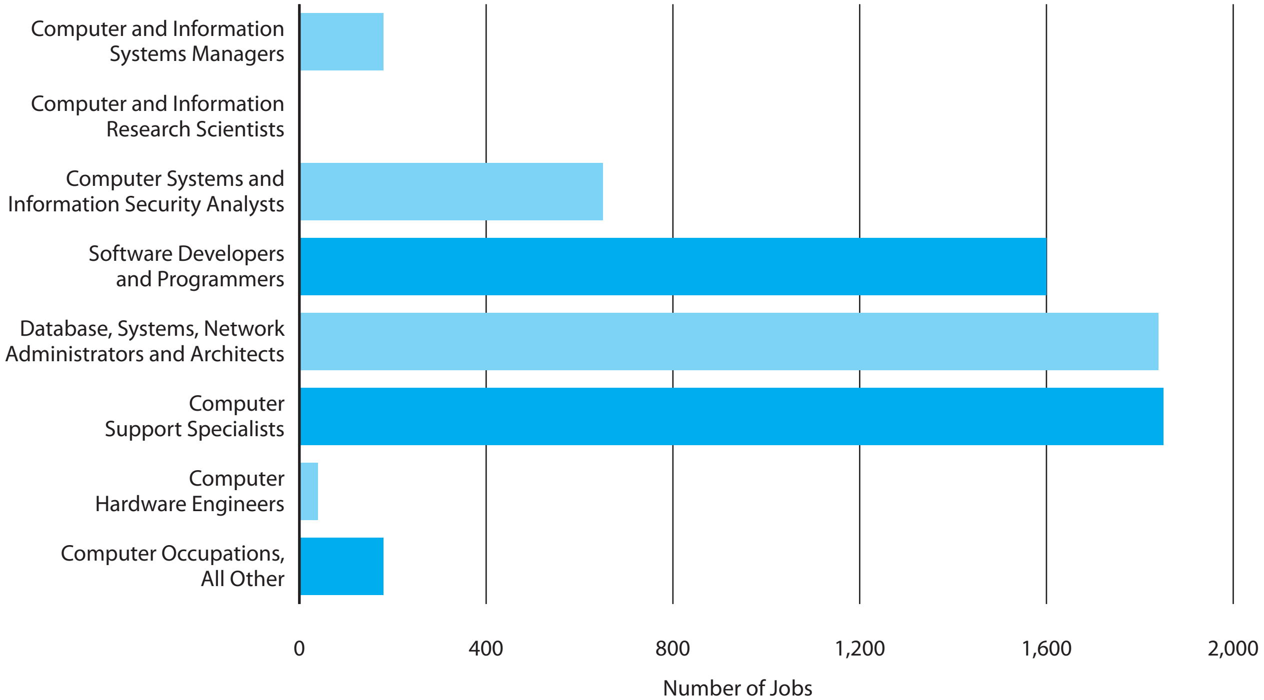


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in South Carolina in 2012

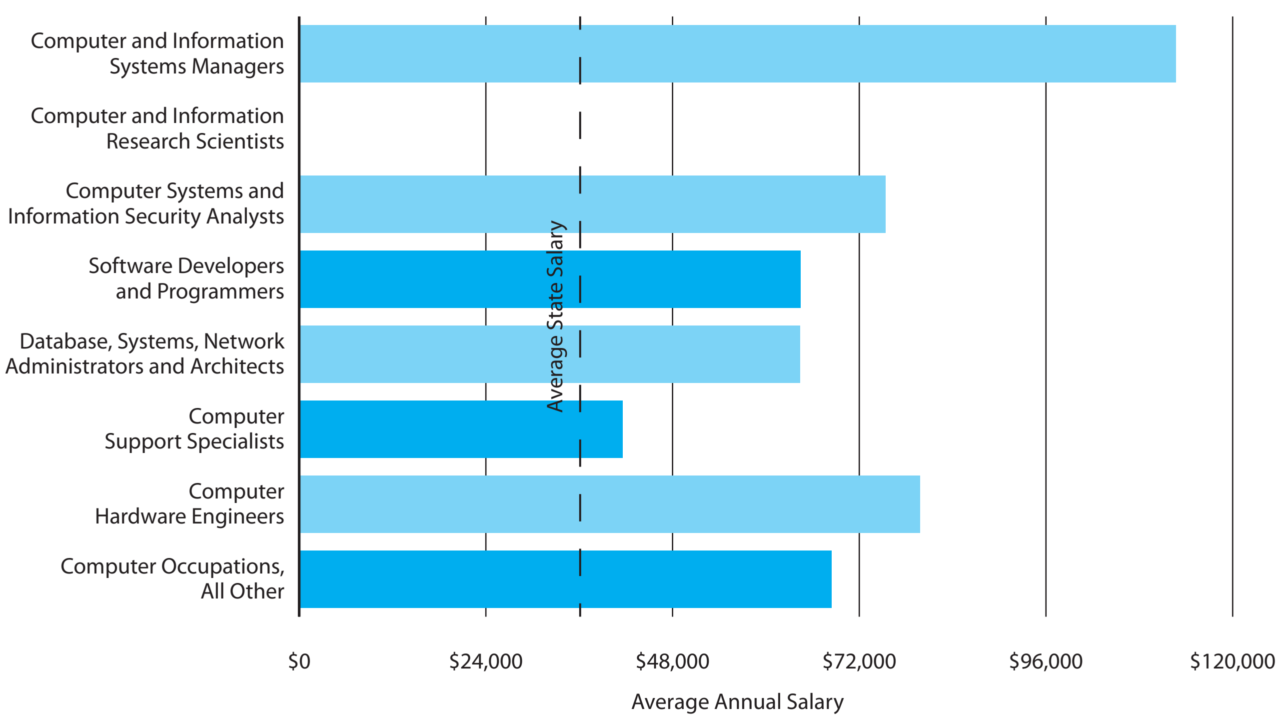


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in South Dakota in 2012



Average Annual Salaries in Computing in South Dakota in 2012



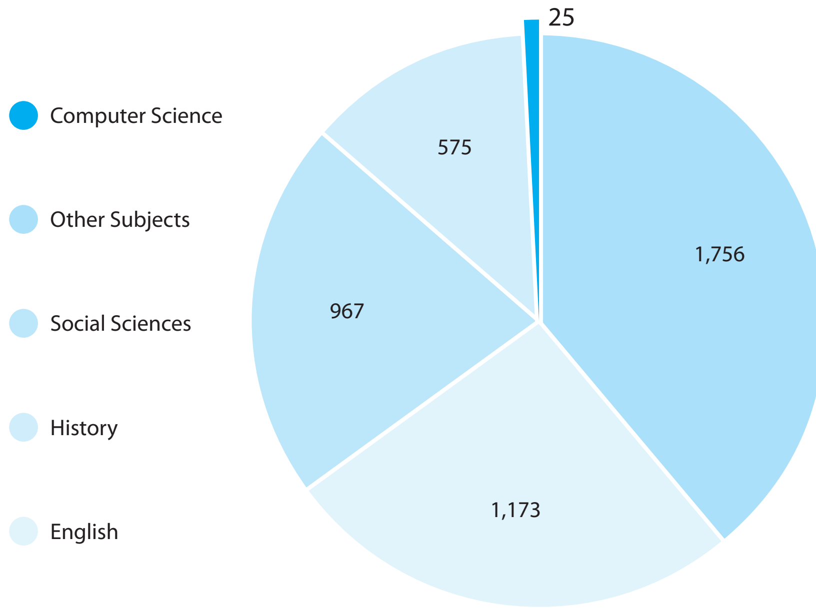
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

South Dakota

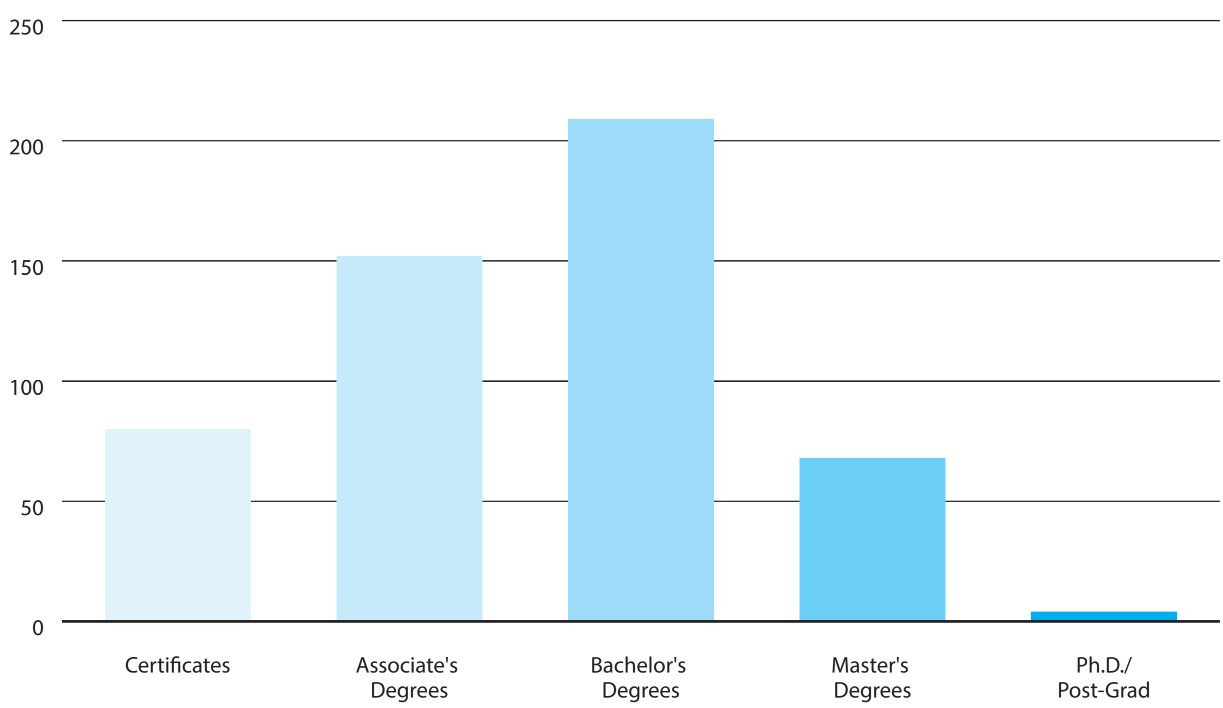
High School Graduation Requirements

South Dakota does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in South Dakota in 2012

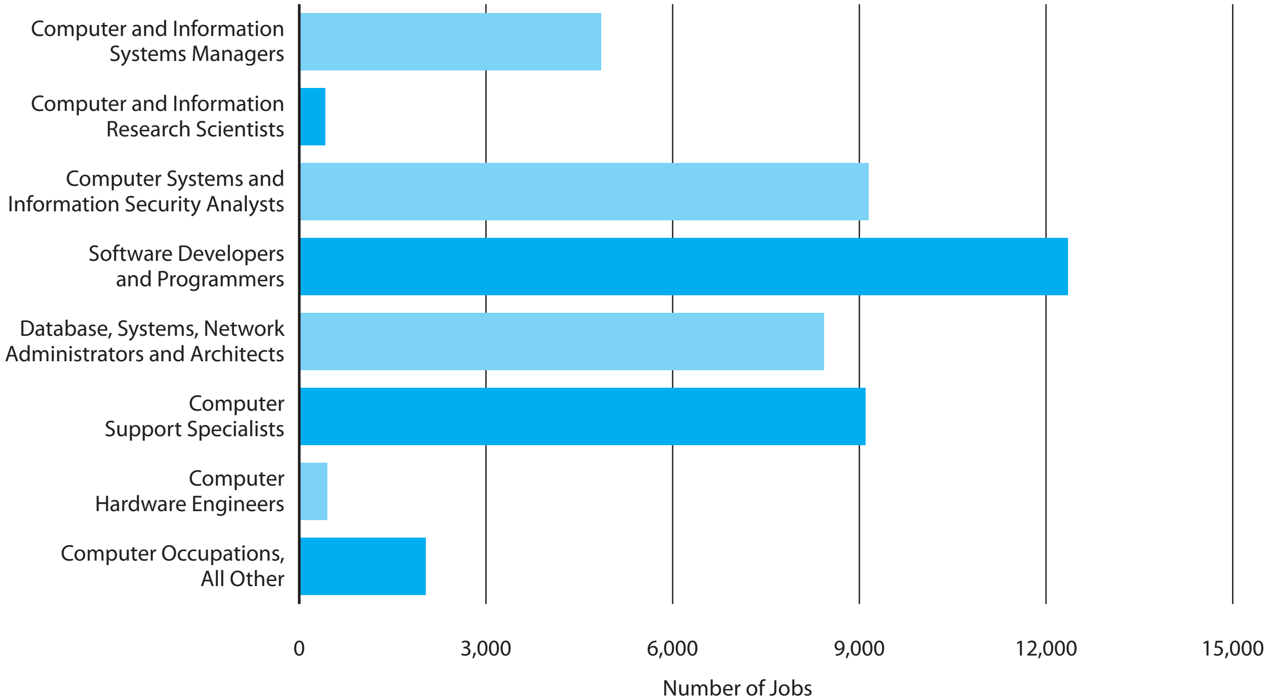


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in South Dakota in 2012

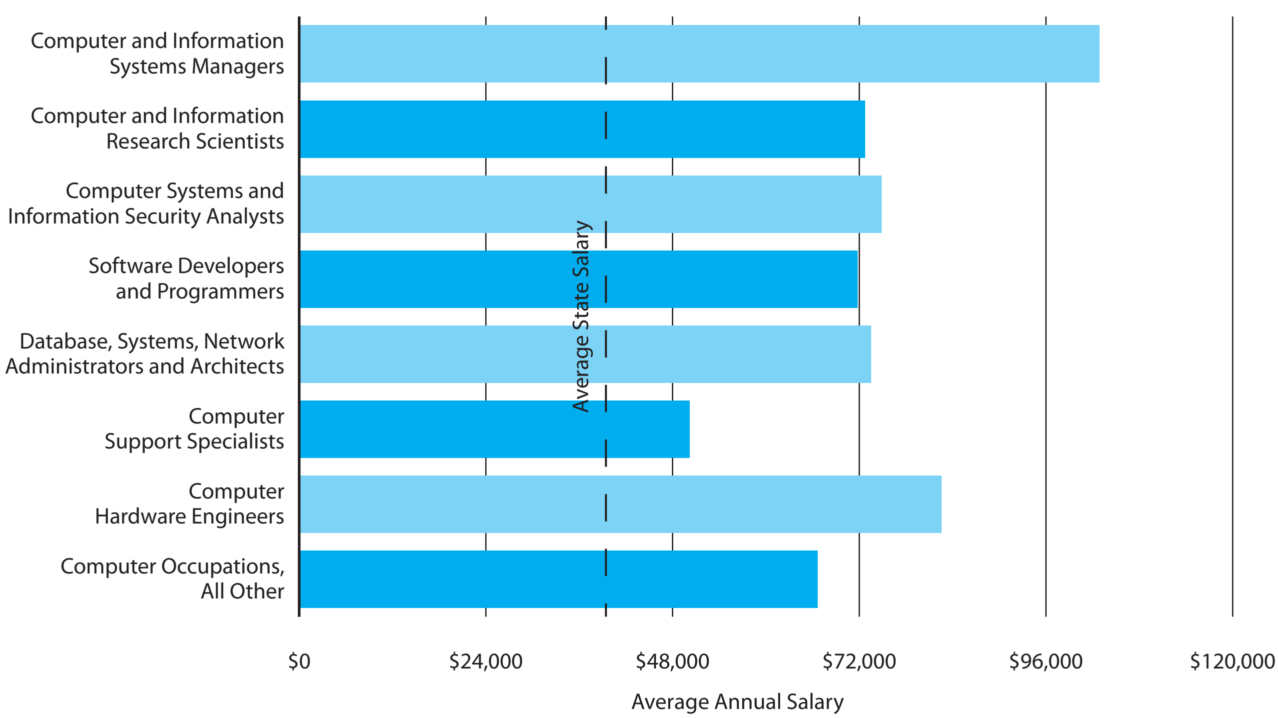


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Tennessee in 2012



Average Annual Salaries in Computing in Tennessee in 2012



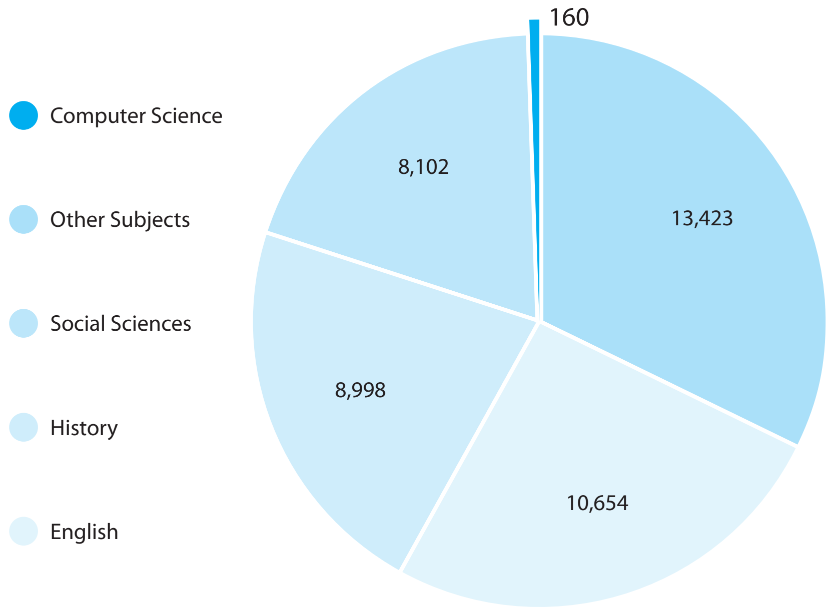
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Tennessee

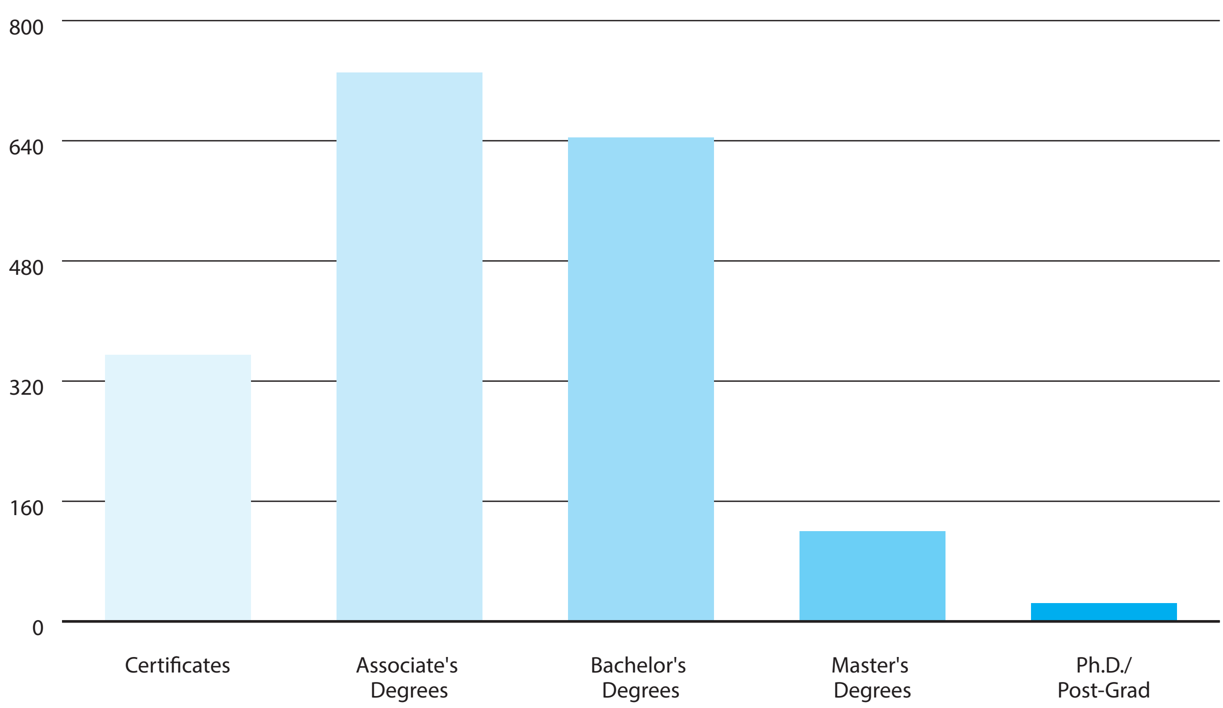
High School Graduation Requirements

Tennessee clearly allows computer science to satisfy a core high school graduation requirement in mathematics.

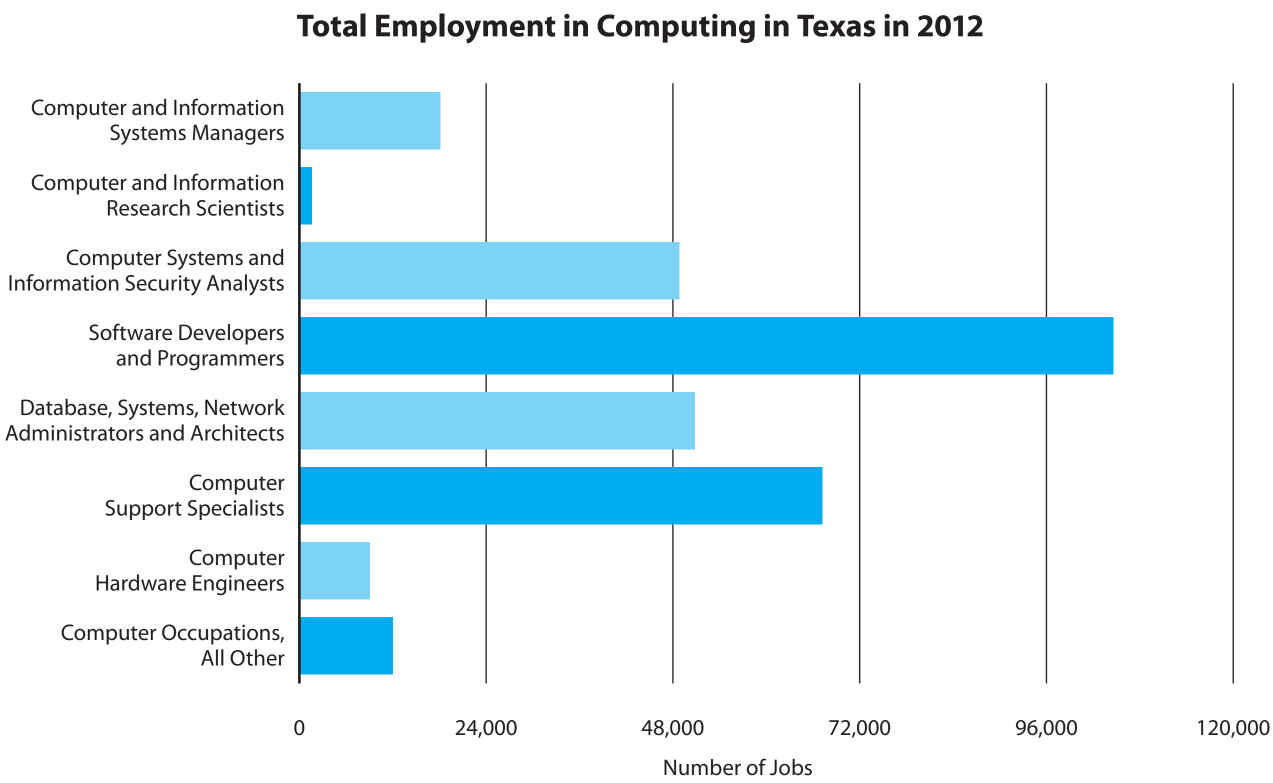
Advanced Placement Exams in Tennessee in 2012

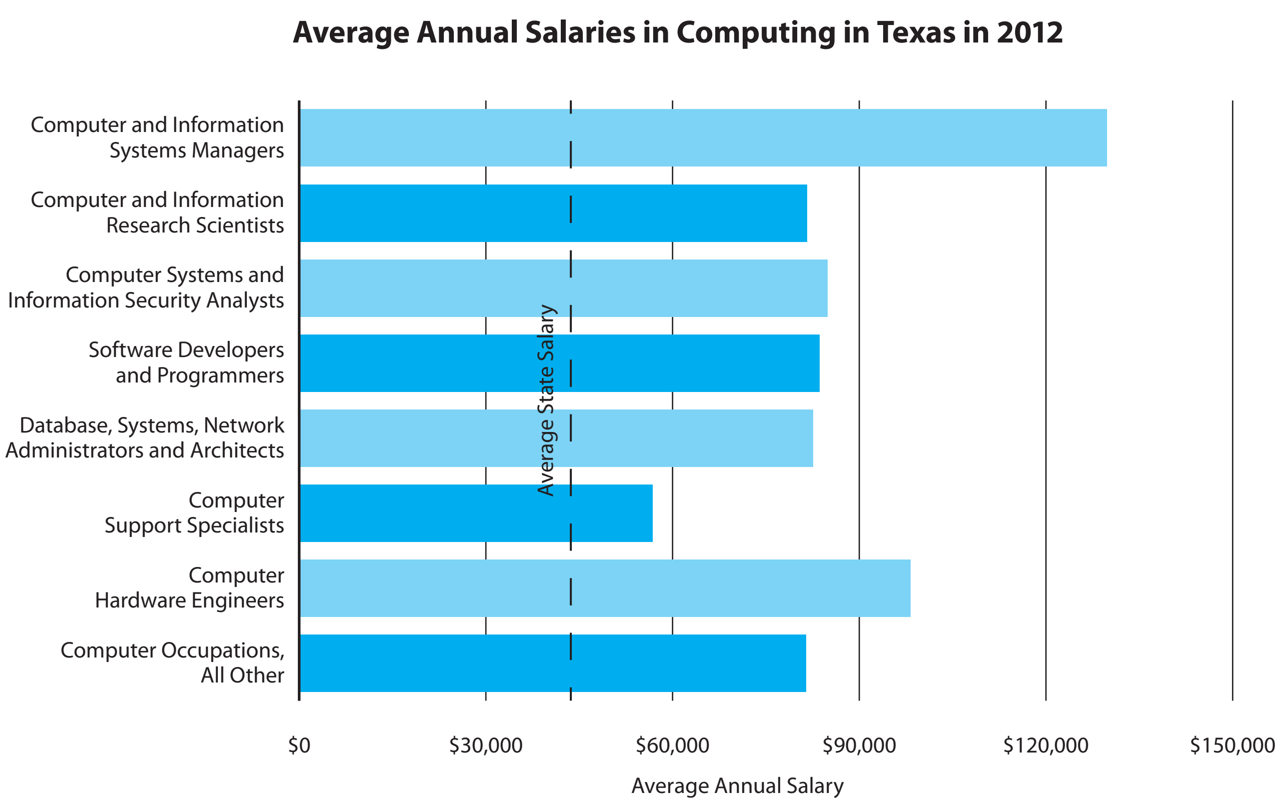


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Tennessee in 2012



Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).





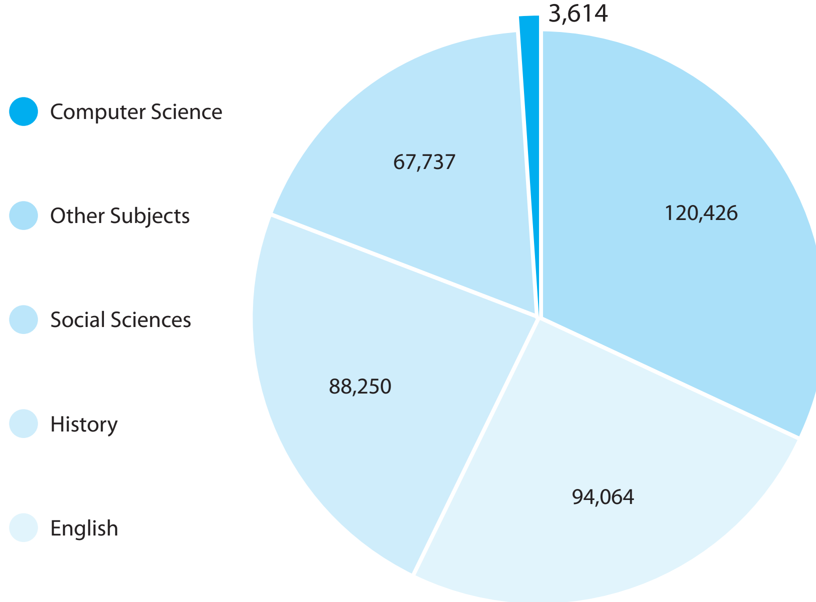
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Texas

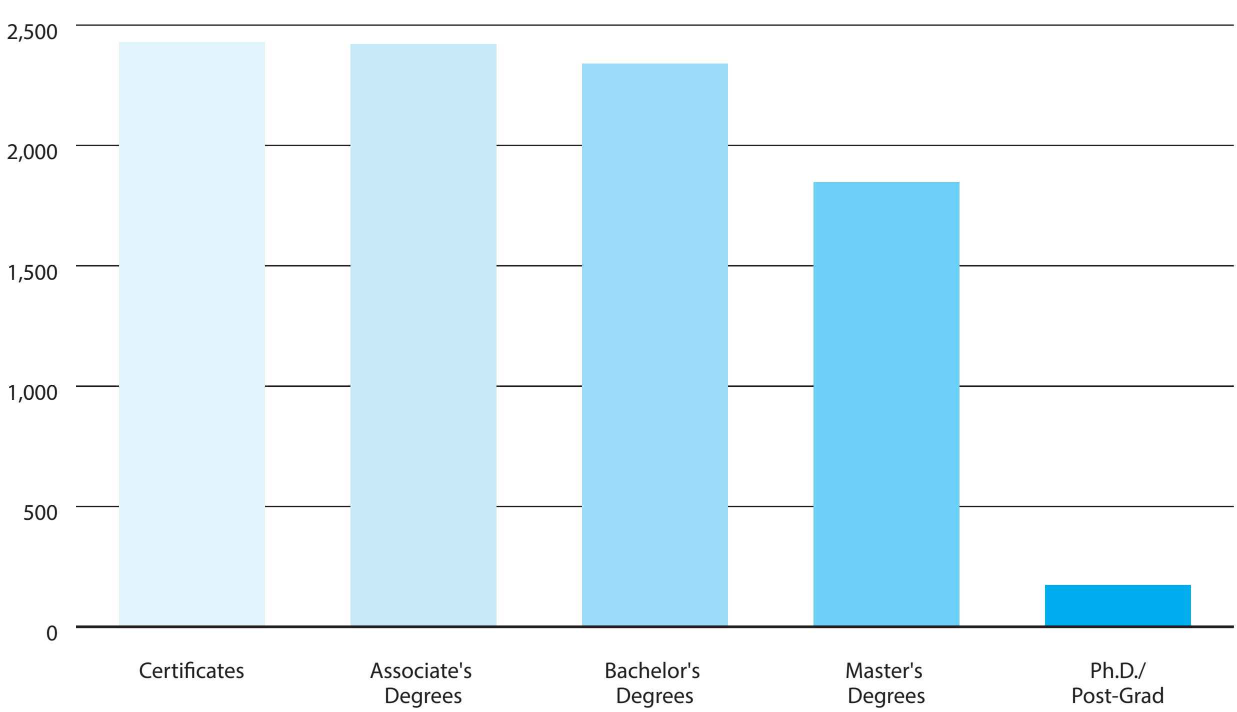
High School Graduation Requirements

Texas clearly allows computer science to satisfy a core high school graduation requirement in mathematics.

Advanced Placement Exams in Texas in 2012

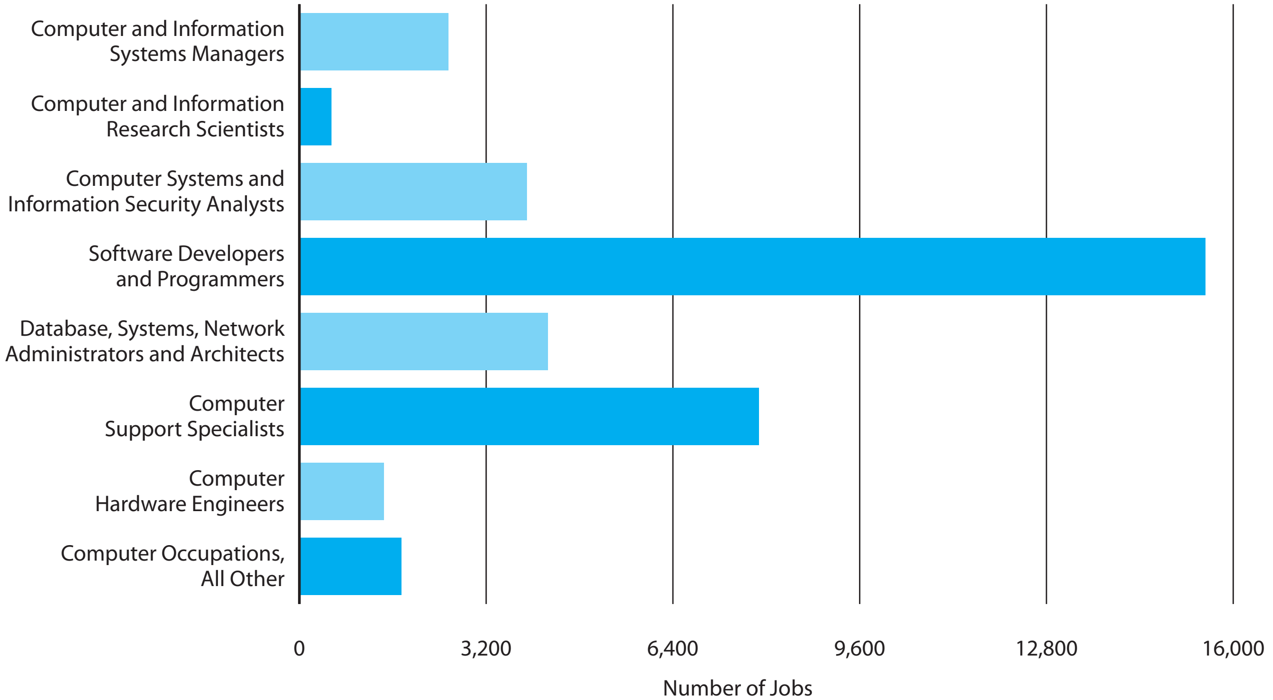


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Texas in 2012

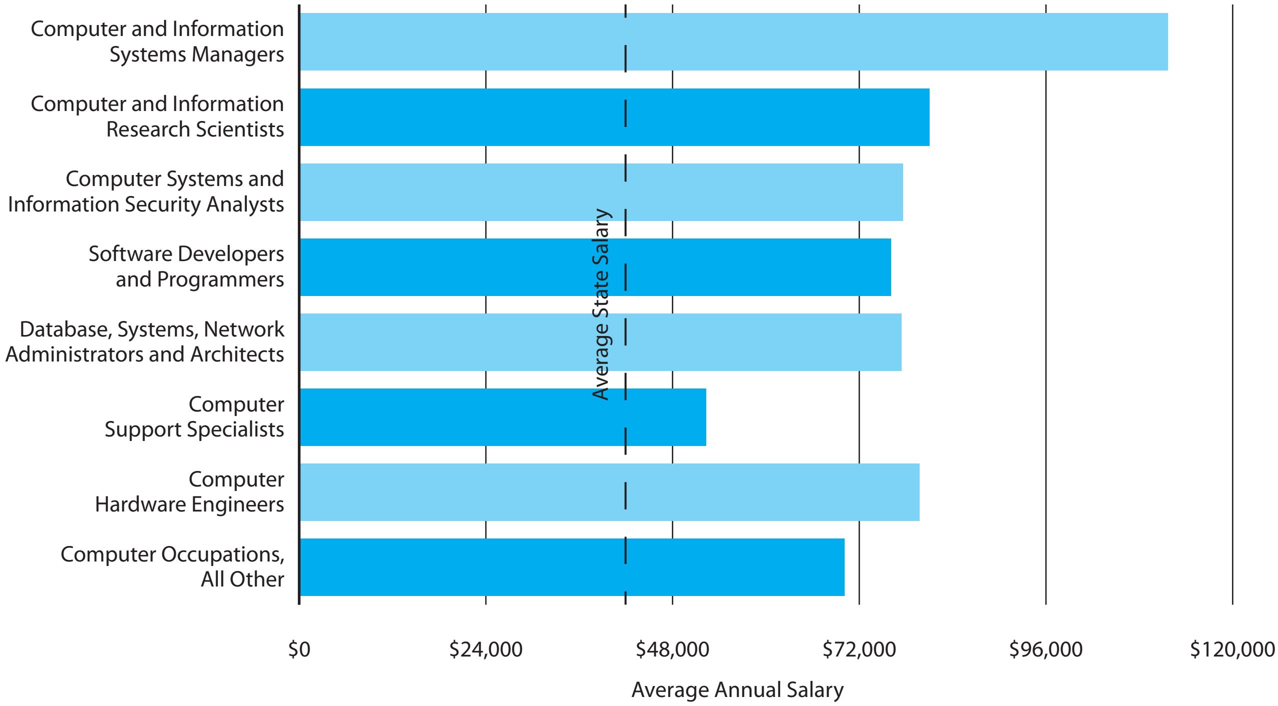


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Utah in 2012



Average Annual Salaries in Computing in Utah in 2012



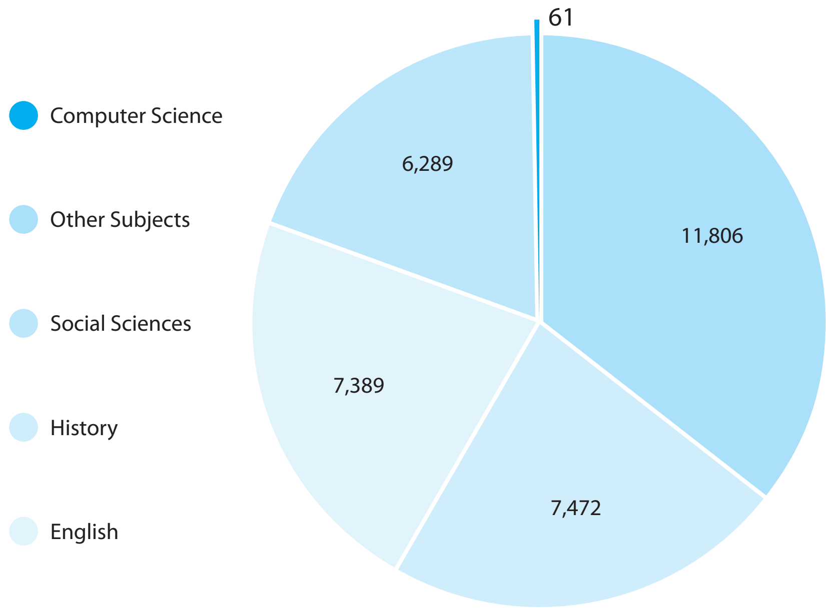
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Utah

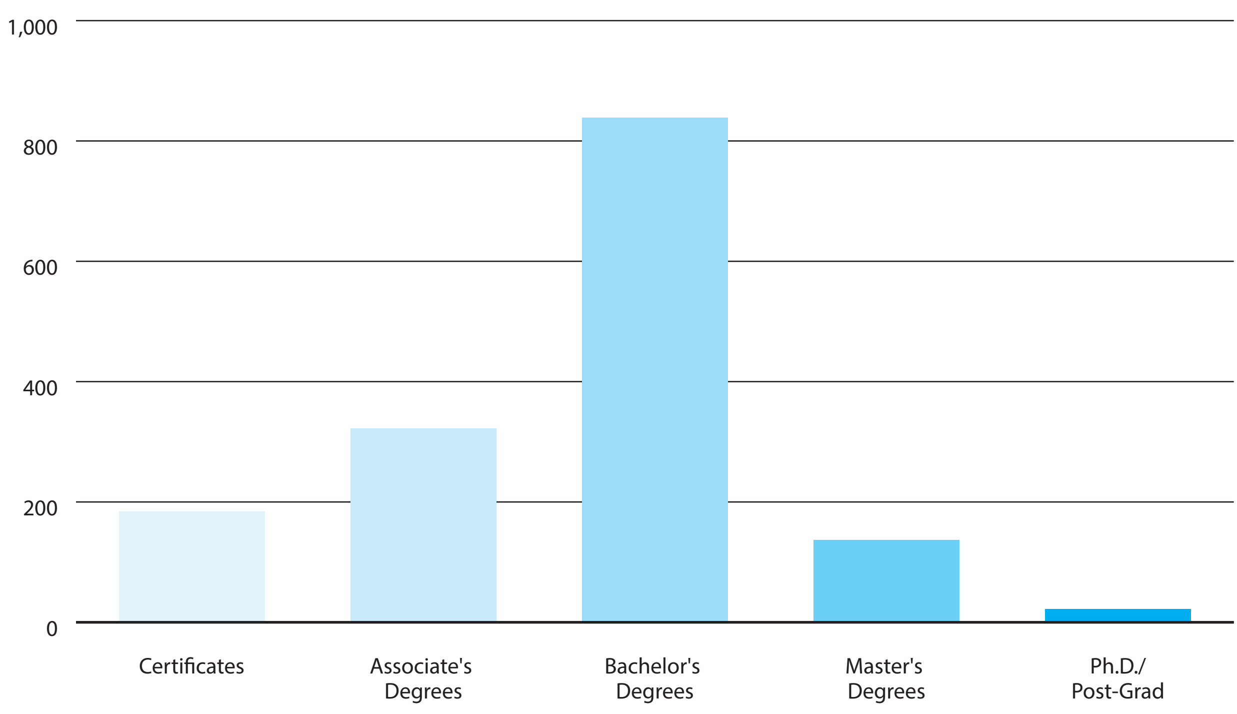
High School Graduation Requirements

Utah clearly allows computer science to satisfy a core high school graduation requirement in mathematics.

Advanced Placement Exams in Utah in 2012

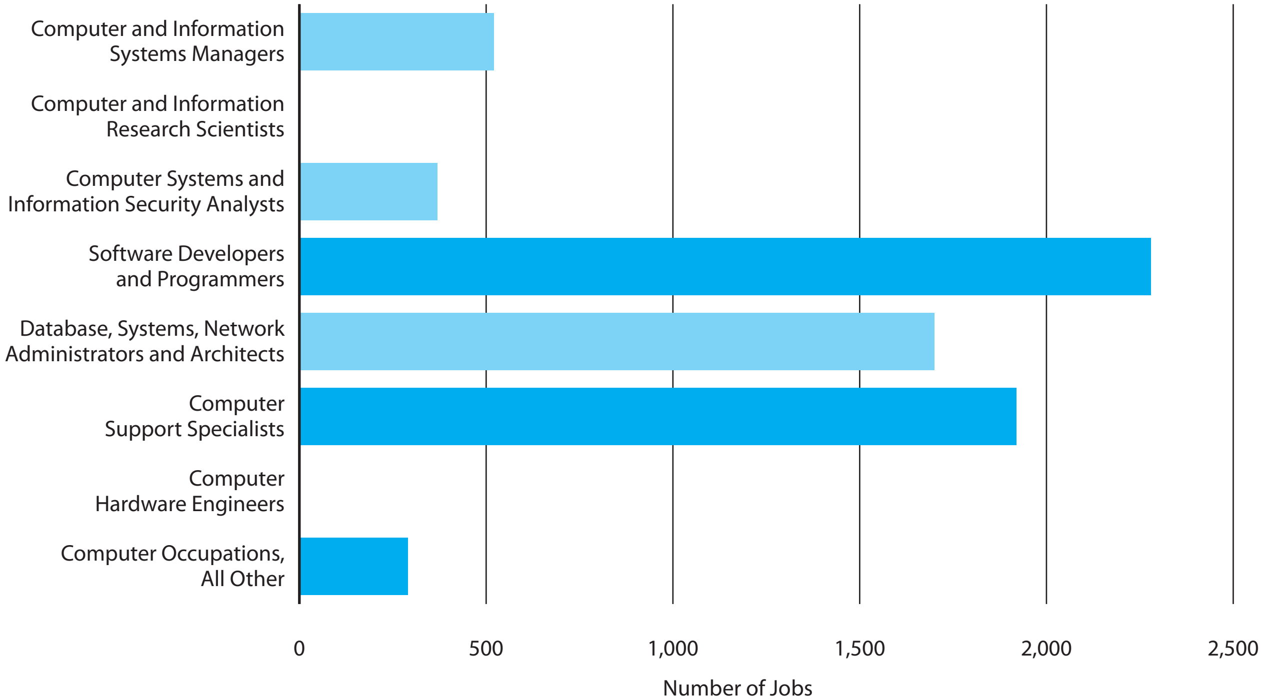


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Utah in 2012

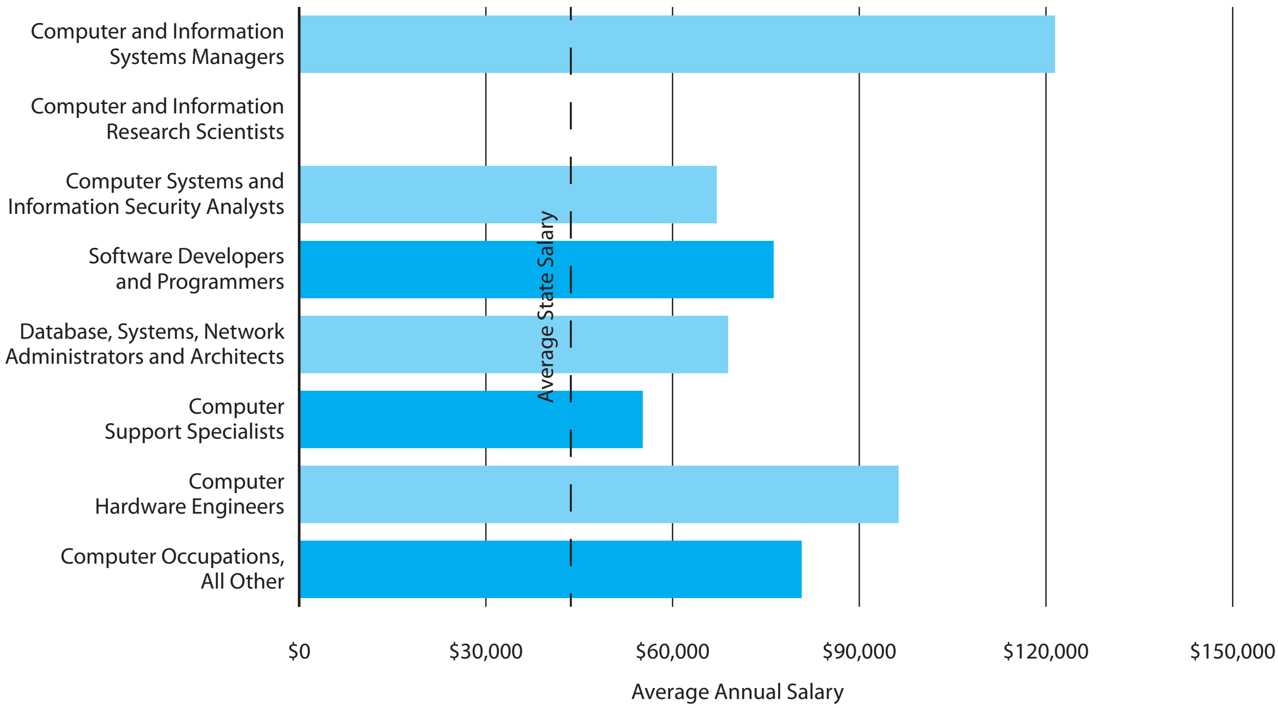


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Vermont in 2012



Average Annual Salaries in Computing in Vermont in 2012



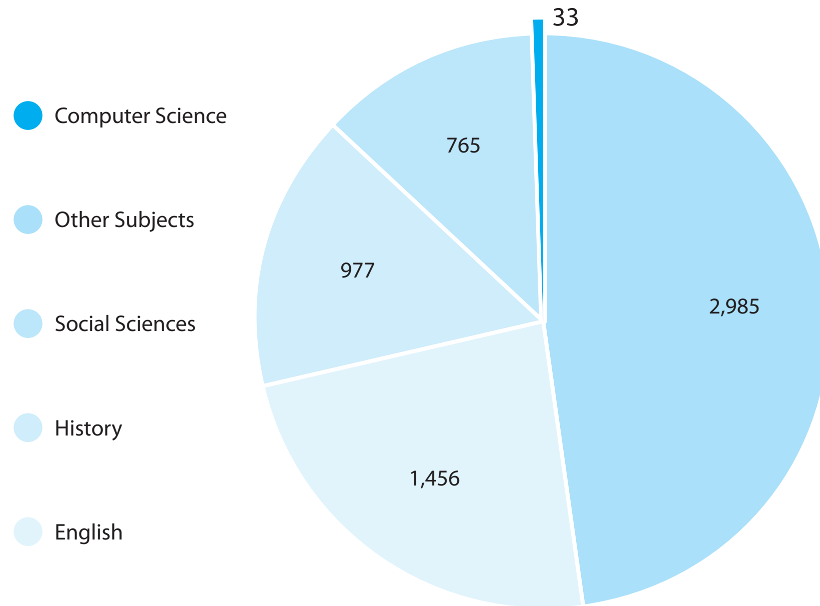
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Vermont

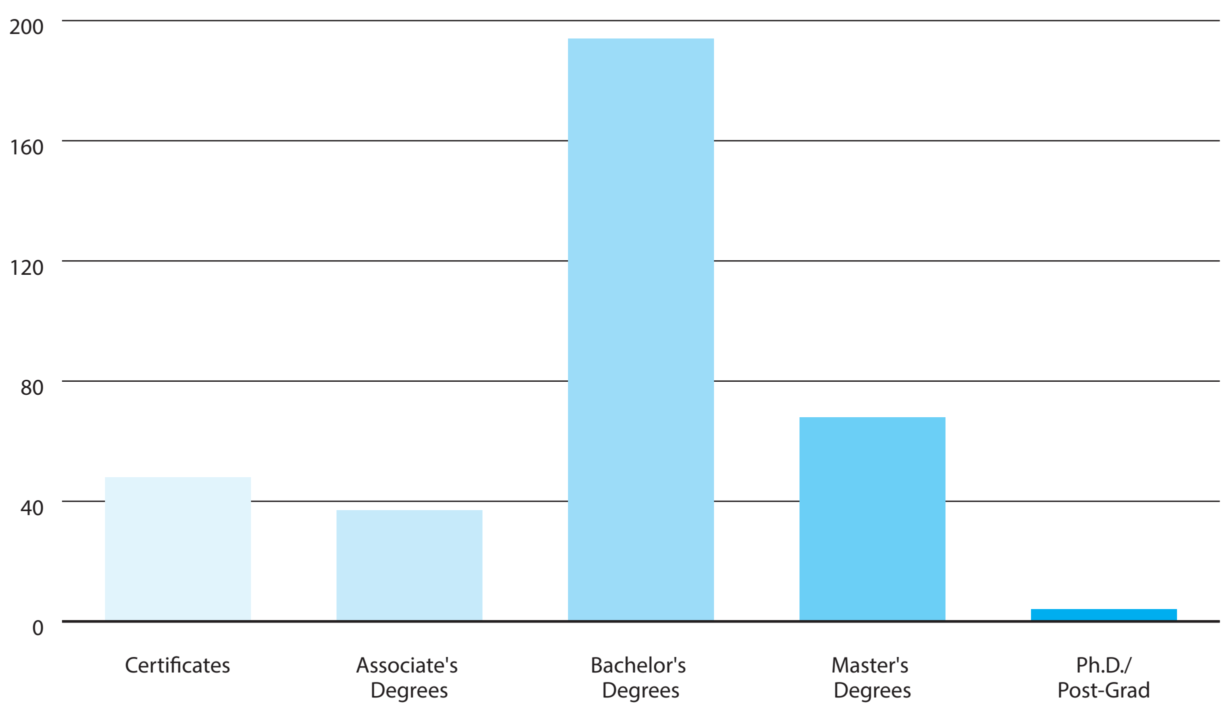
High School Graduation Requirements

Vermont clearly allows computer science to satisfy a core high school graduation requirement in mathematics.

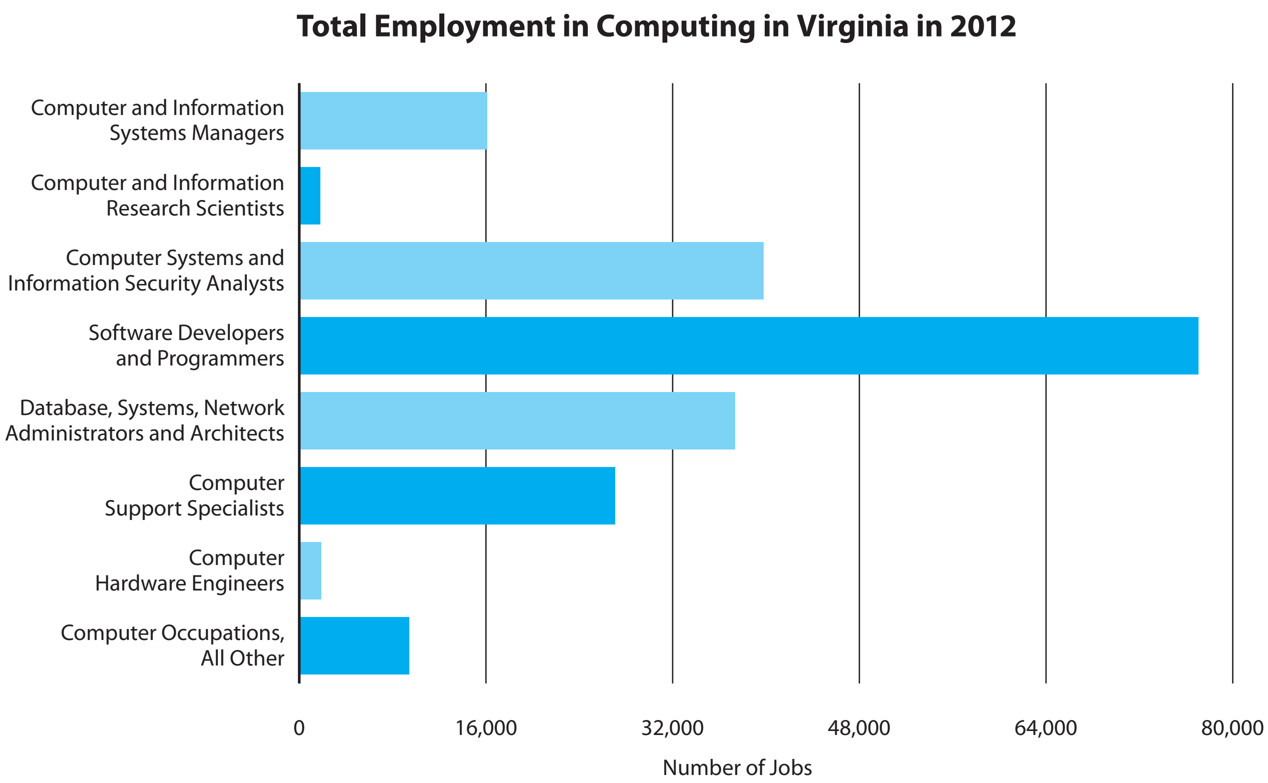
Advanced Placement Exams in Vermont in 2012

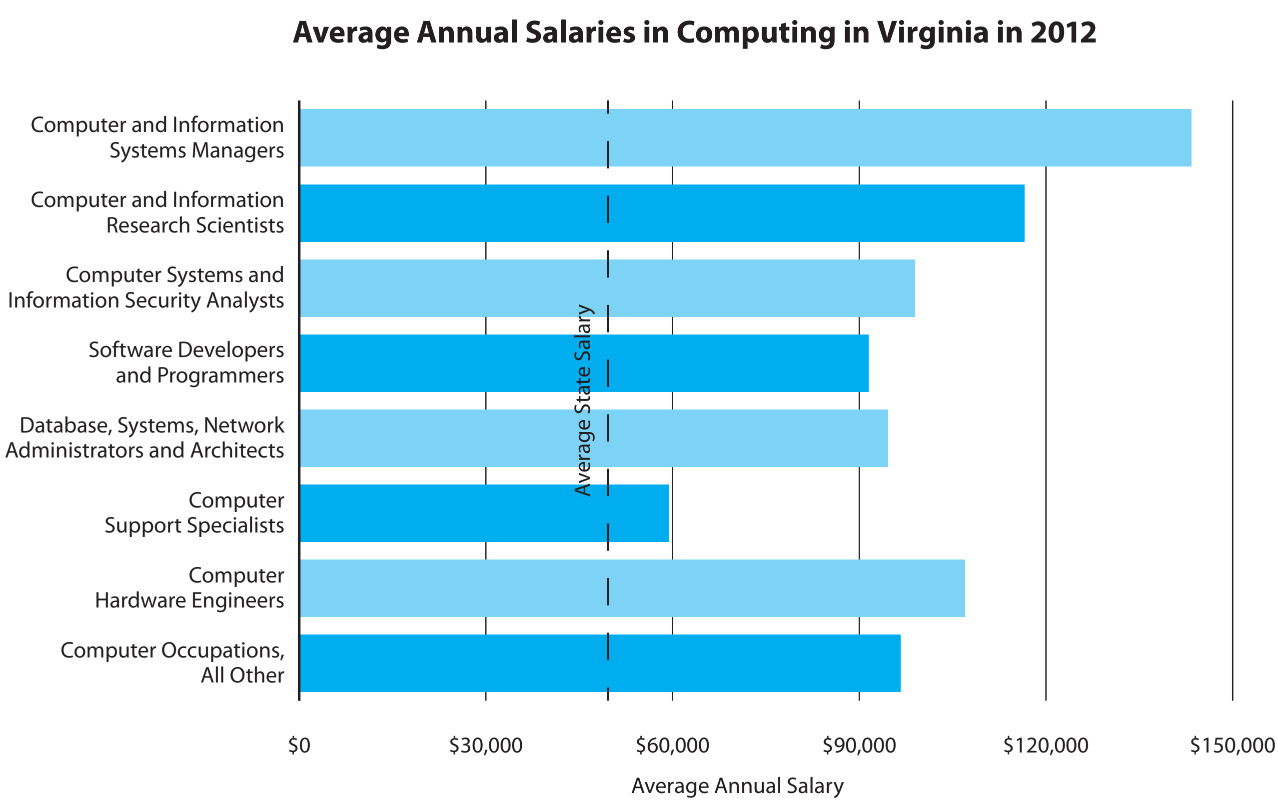


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Vermont in 2012



Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).





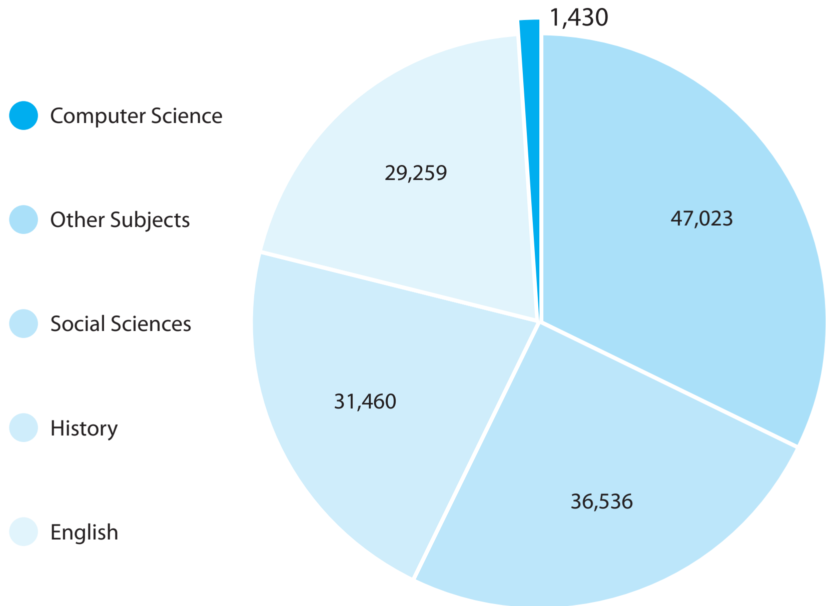
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Virginia

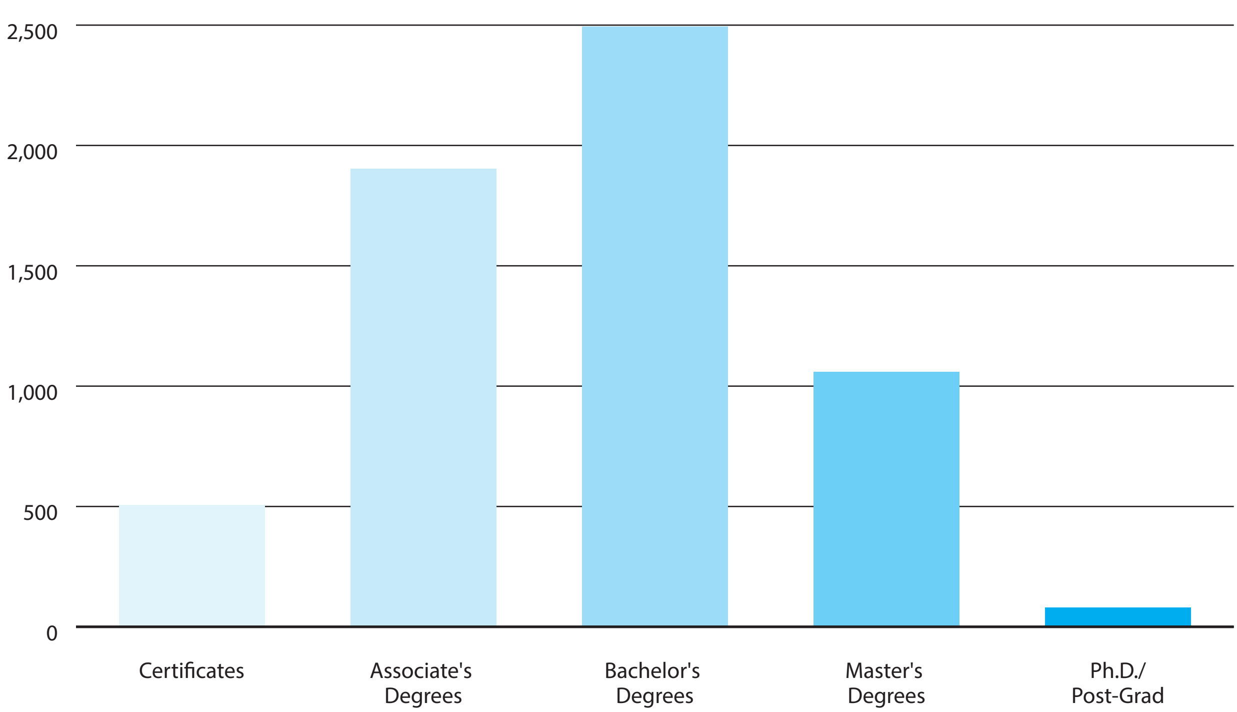
High School Graduation Requirements

Virginia clearly allows computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Virginia in 2012

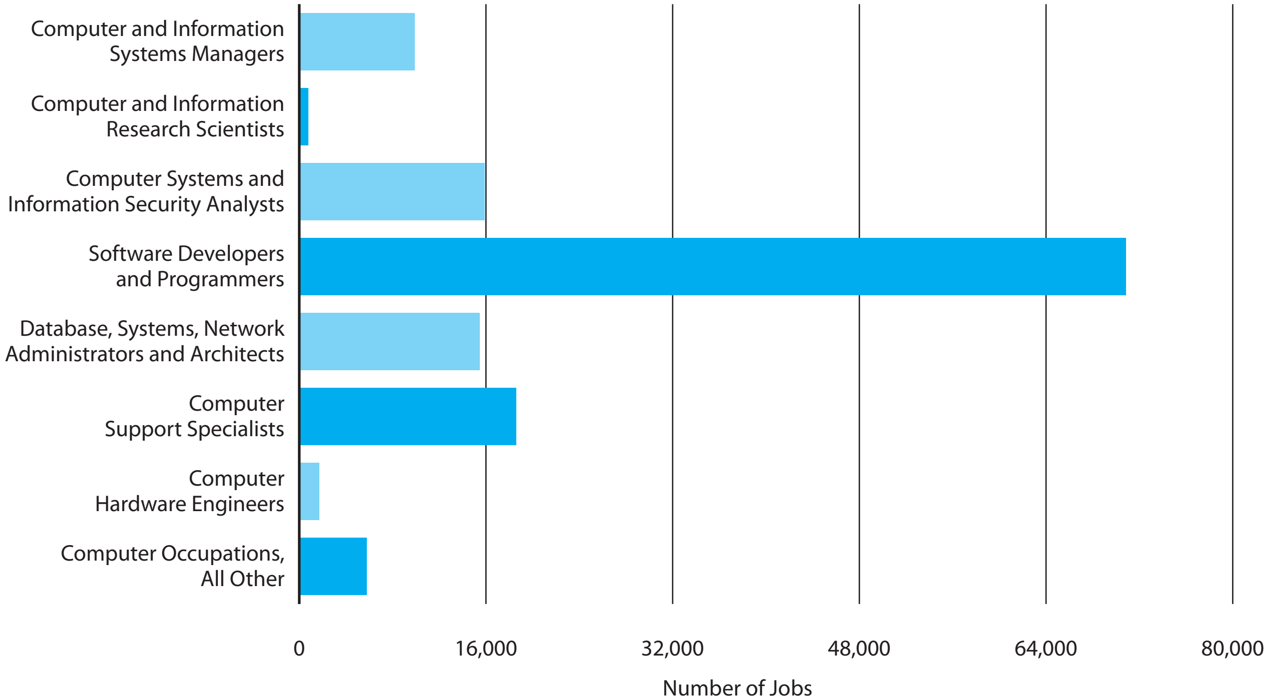


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Virginia in 2012

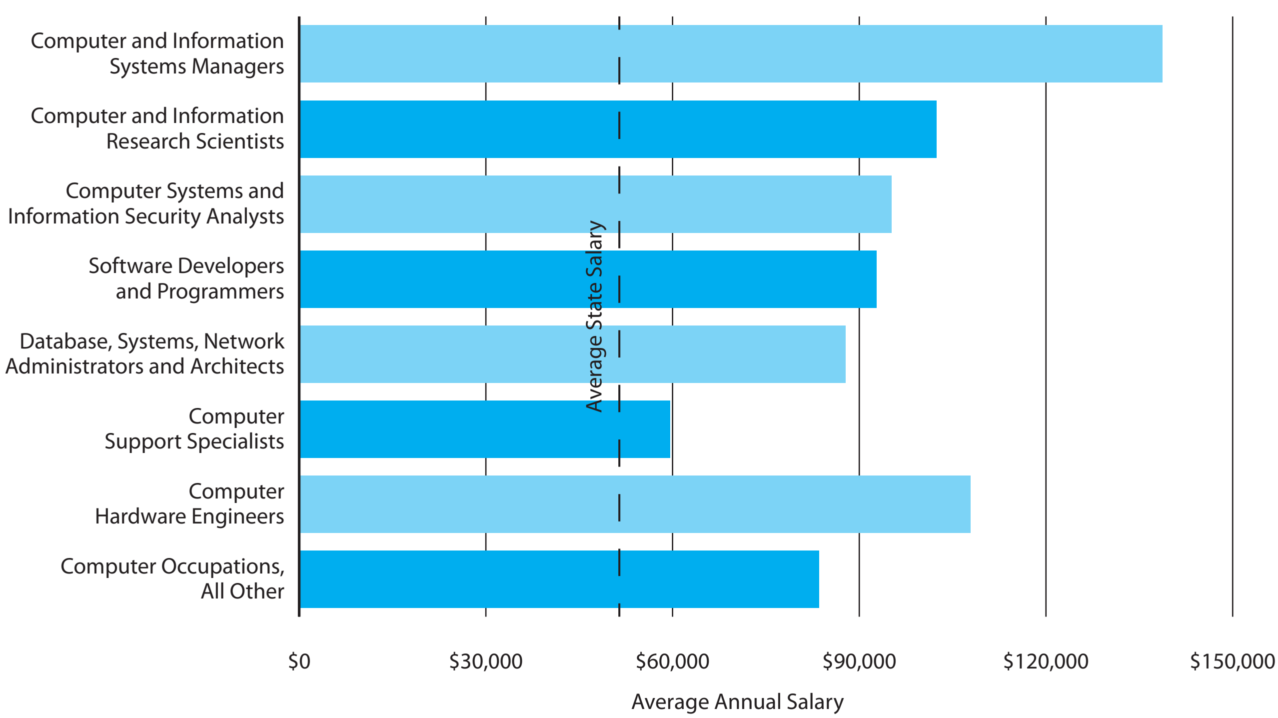


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Washington in 2012



Average Annual Salaries in Computing in Washington in 2012



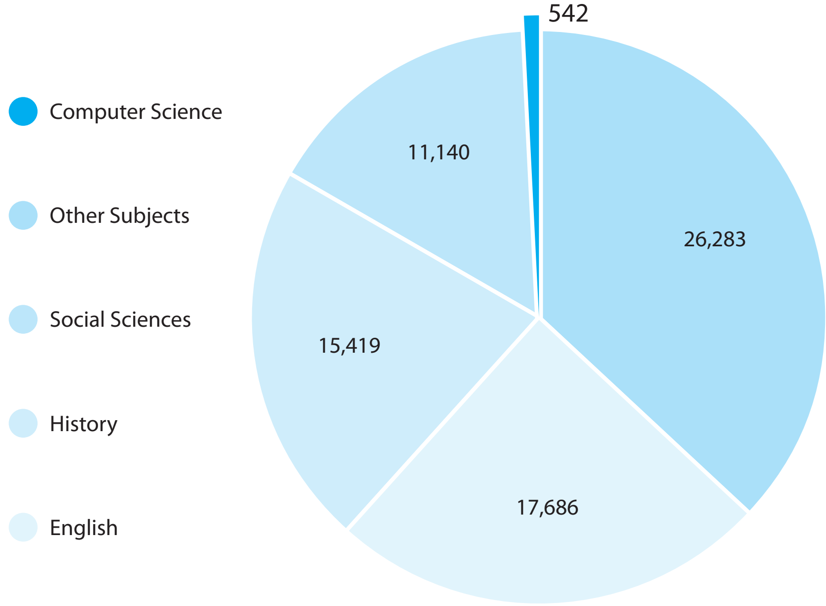
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Washington

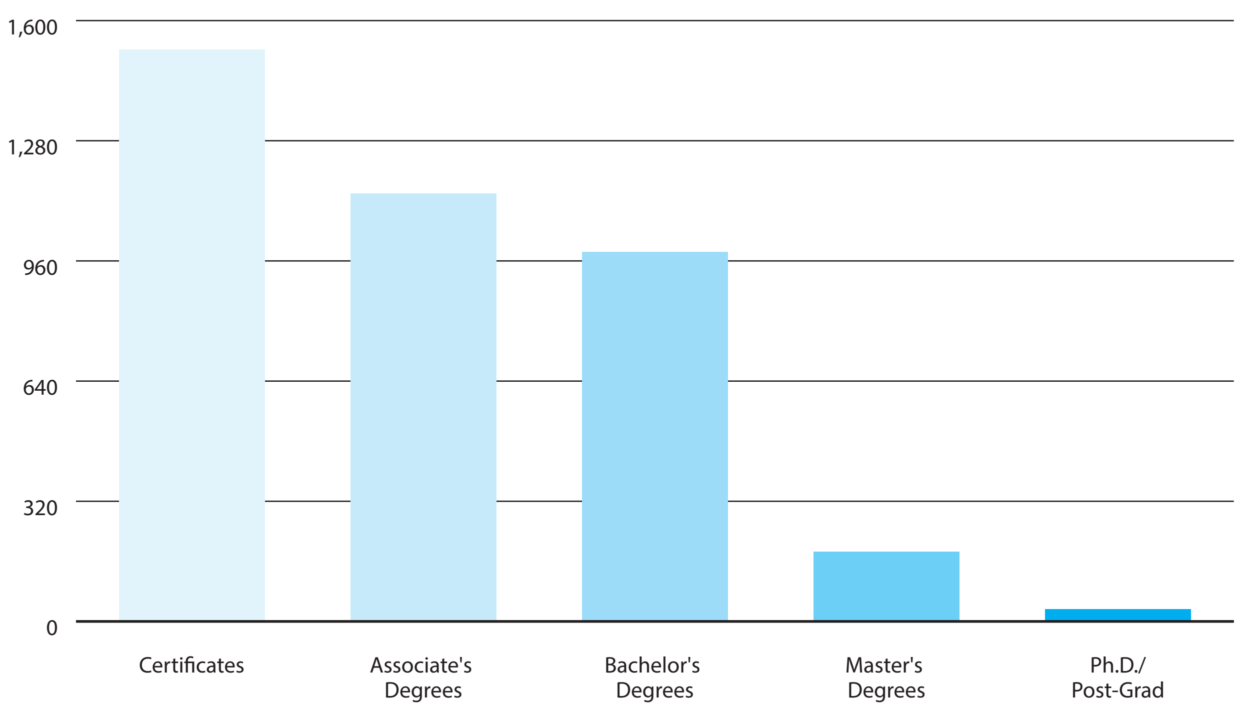
High School Graduation Requirements

Washington clearly allows computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Washington in 2012

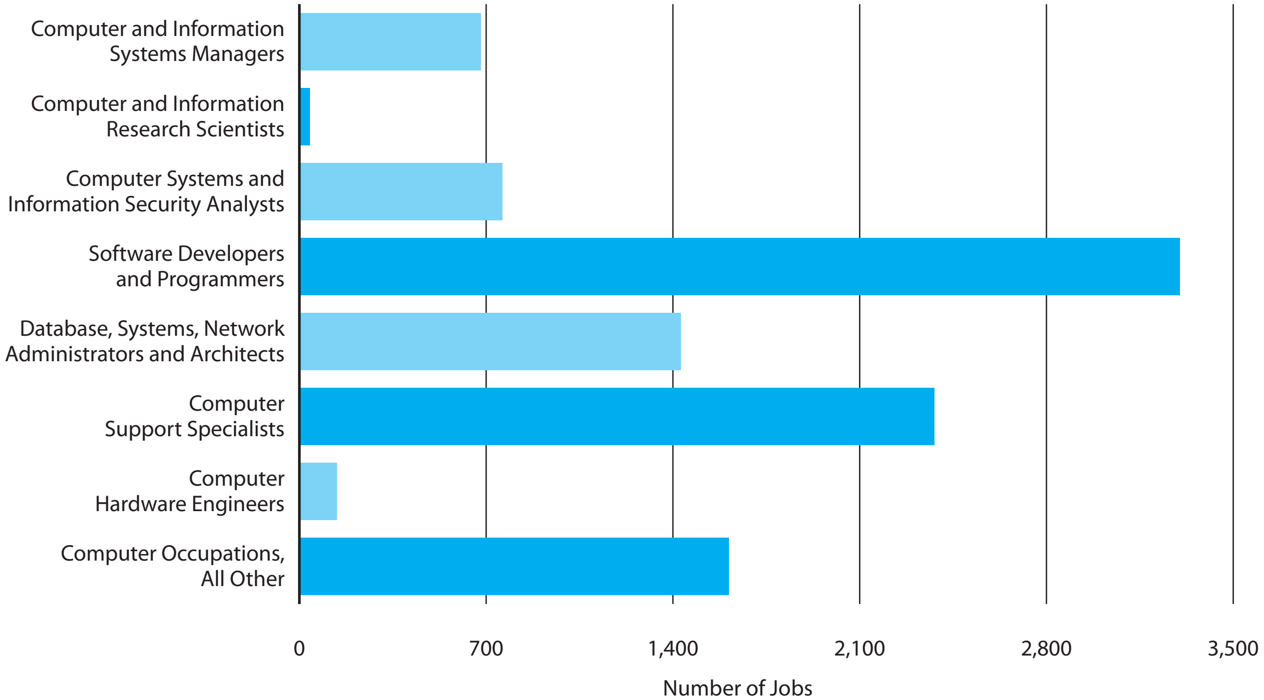


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Washington in 2012

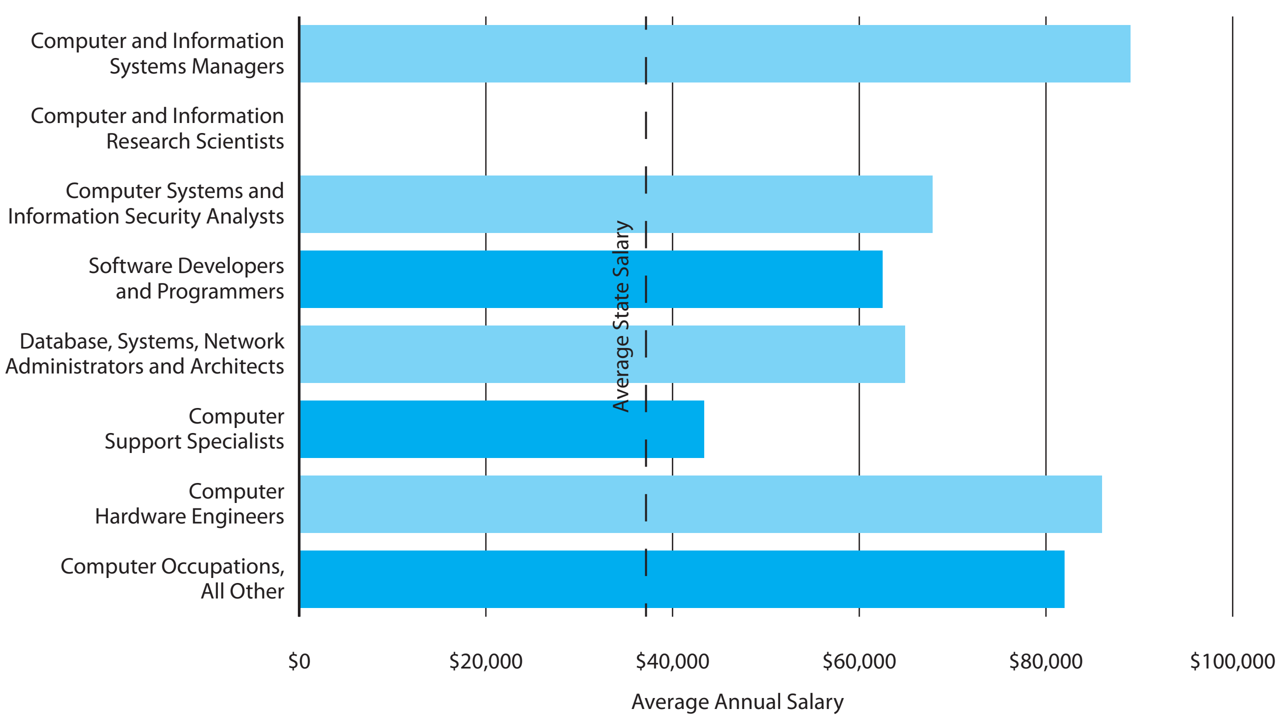


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in West Virginia in 2012



Average Annual Salaries in Computing in West Virginia in 2012



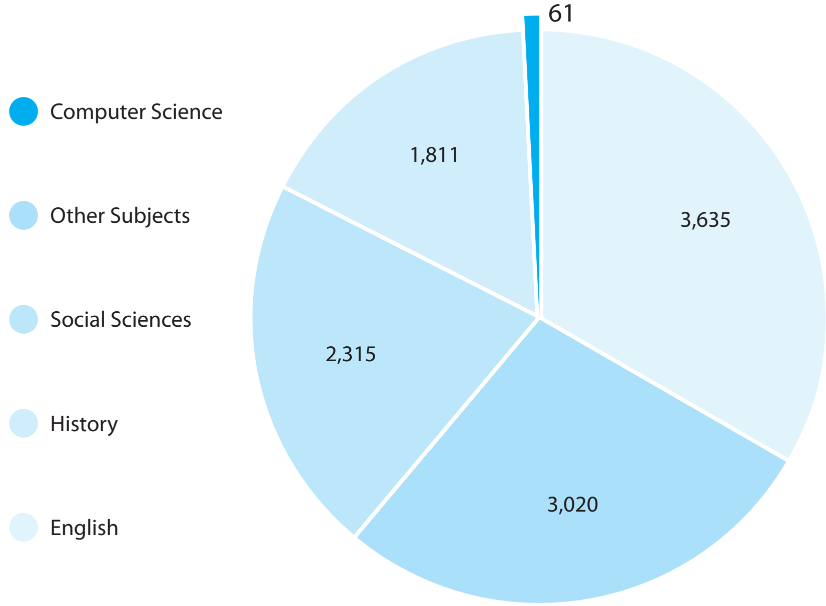
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

West Virginia

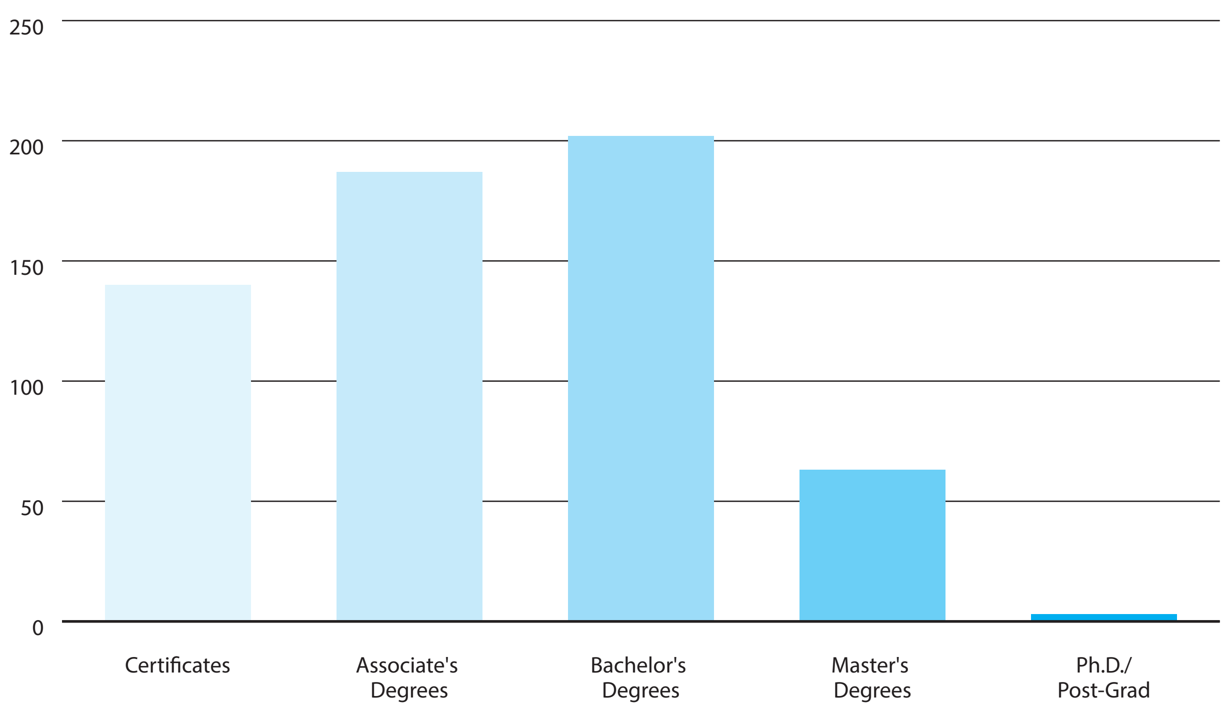
High School Graduation Requirements

West Virginia does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

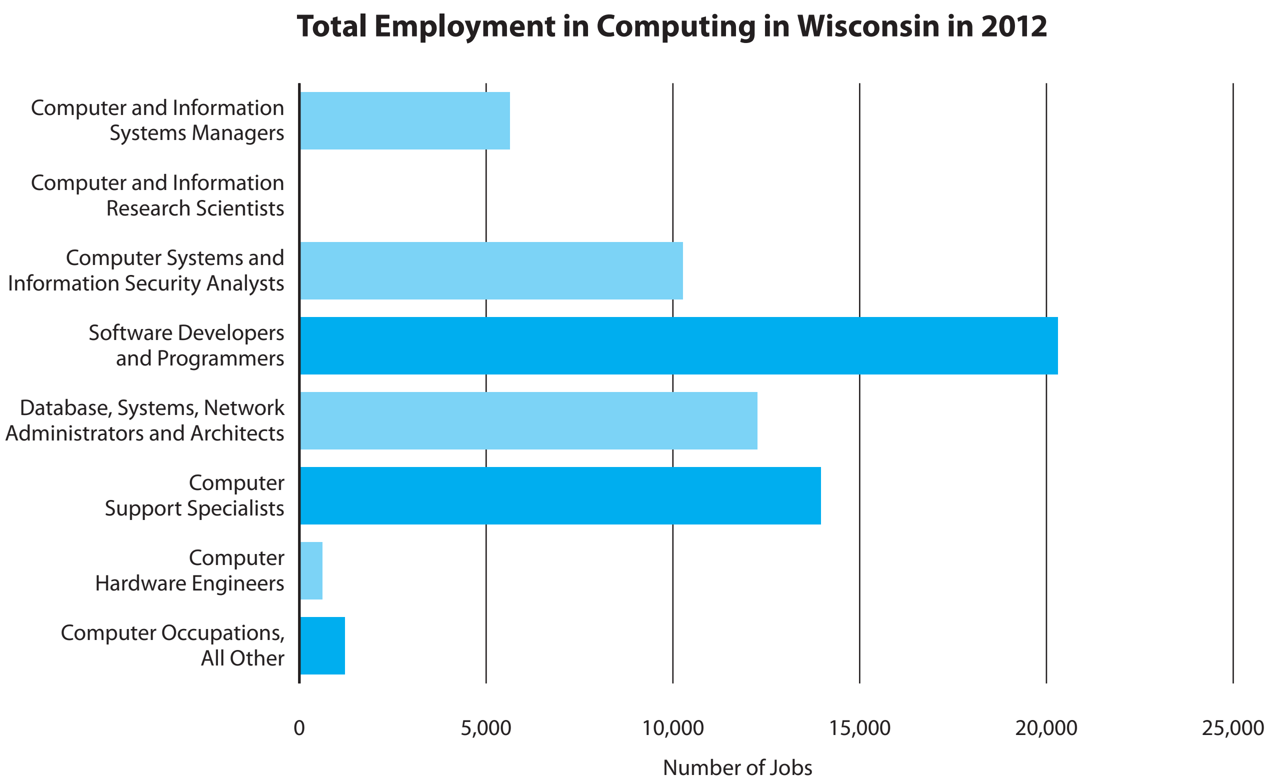
Advanced Placement Exams in West Virginia in 2012

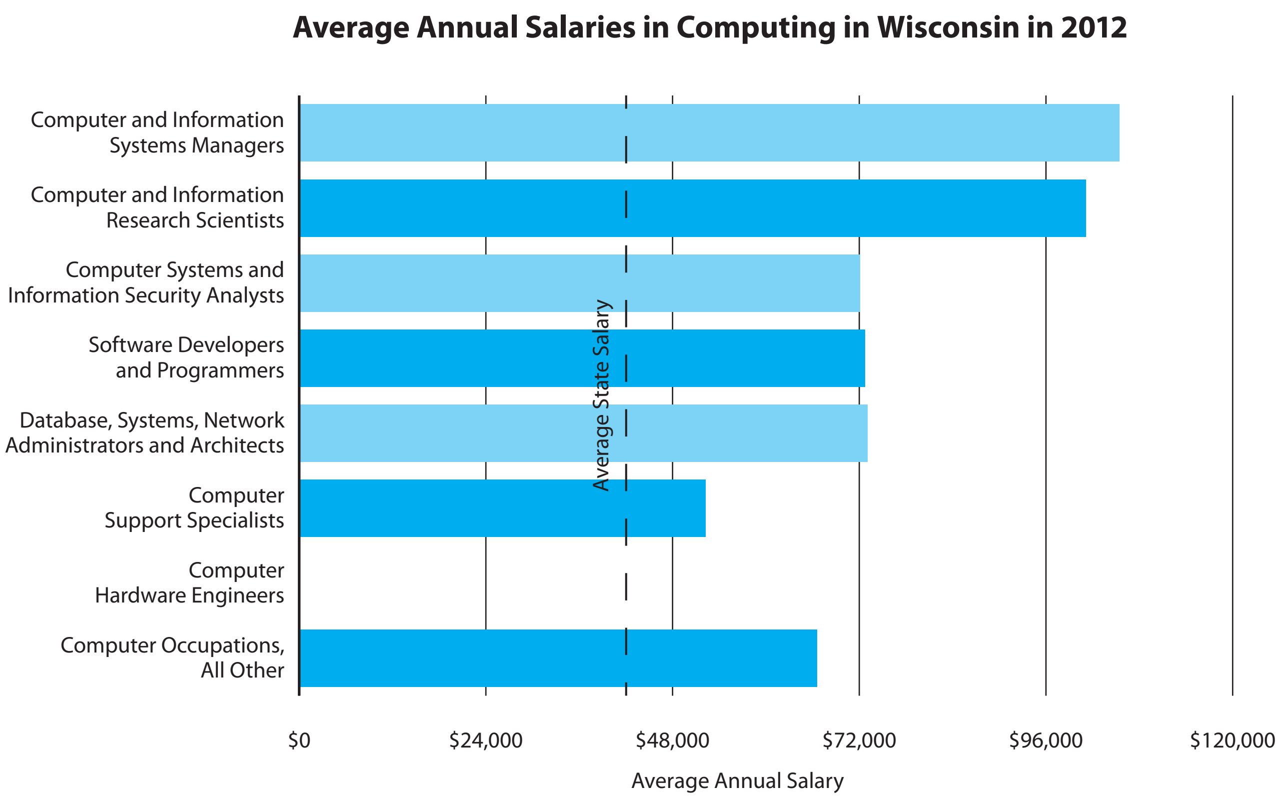


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in West Virginia in 2012



Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).





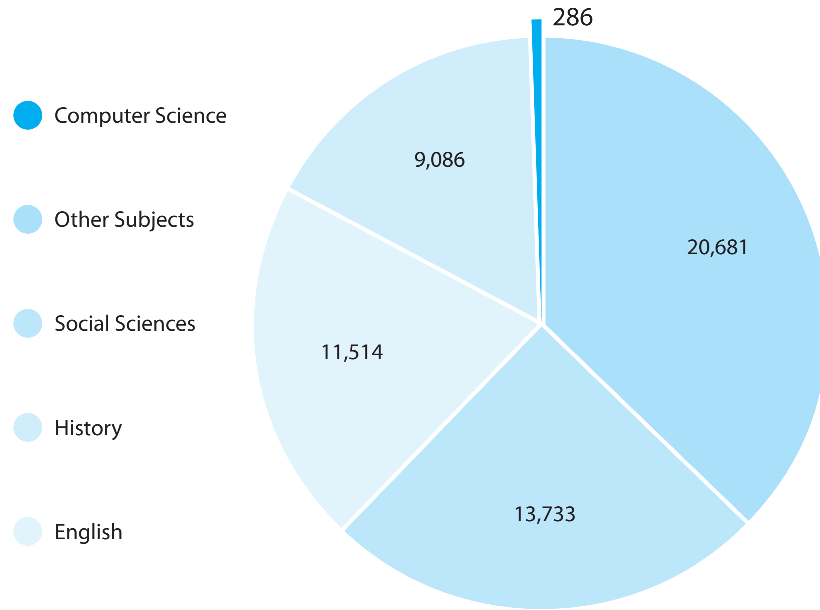
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Wisconsin

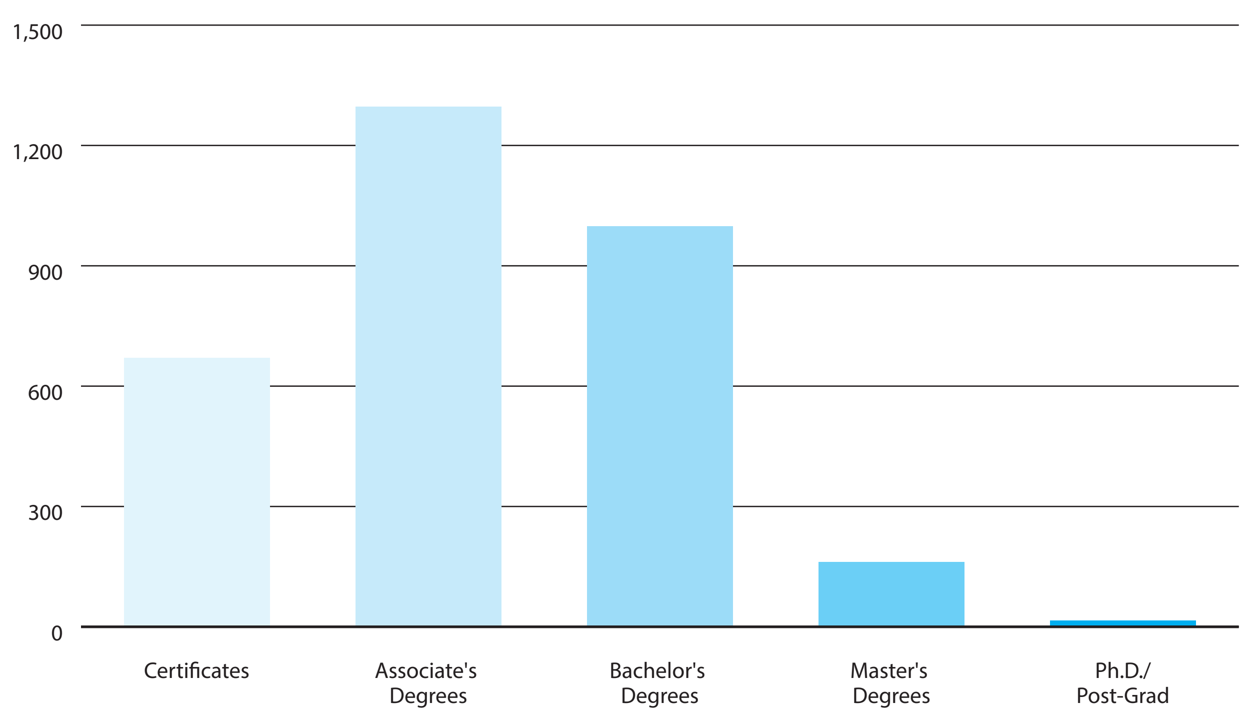
High School Graduation Requirements

Wisconsin clearly allows computer science to satisfy a core high school graduation requirement in mathematics.

Advanced Placement Exams in Wisconsin in 2012

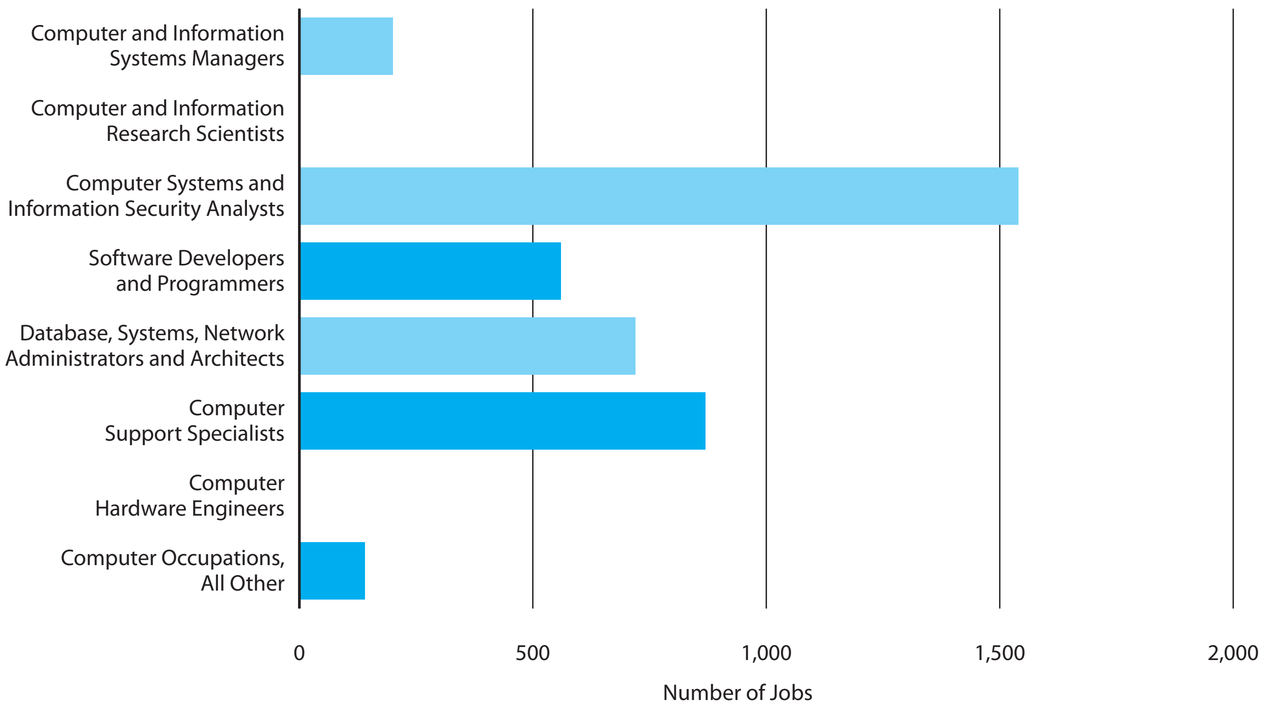


Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Wisconsin in 2012

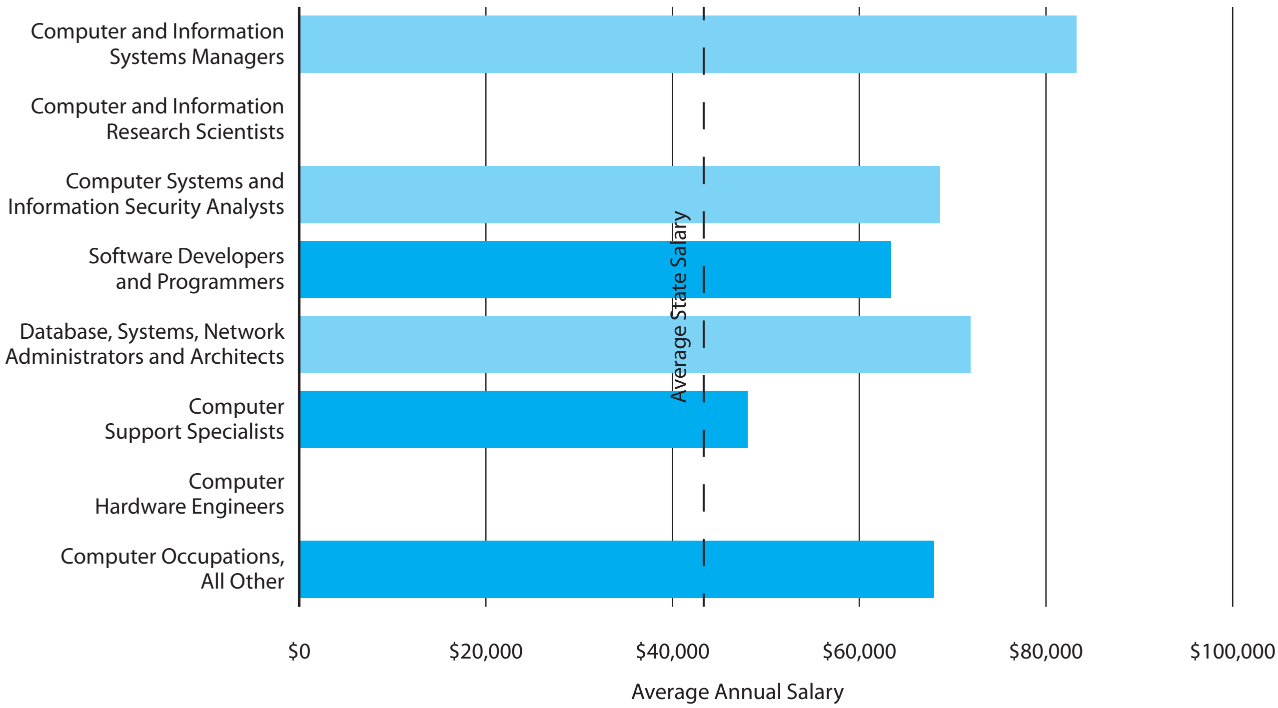


Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

Total Employment in Computing in Wyoming in 2012



Average Annual Salaries in Computing in Wyoming in 2012



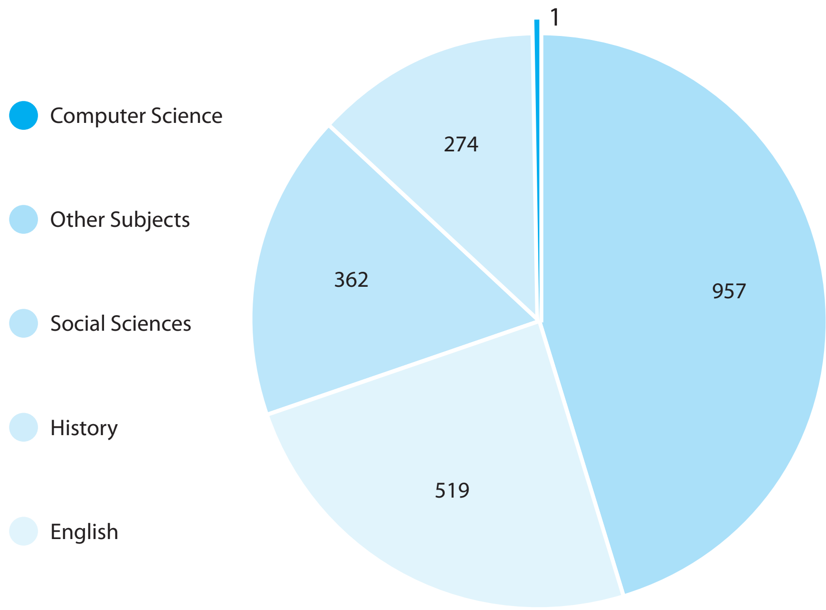
Source: U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates (May 2012).

Wyoming

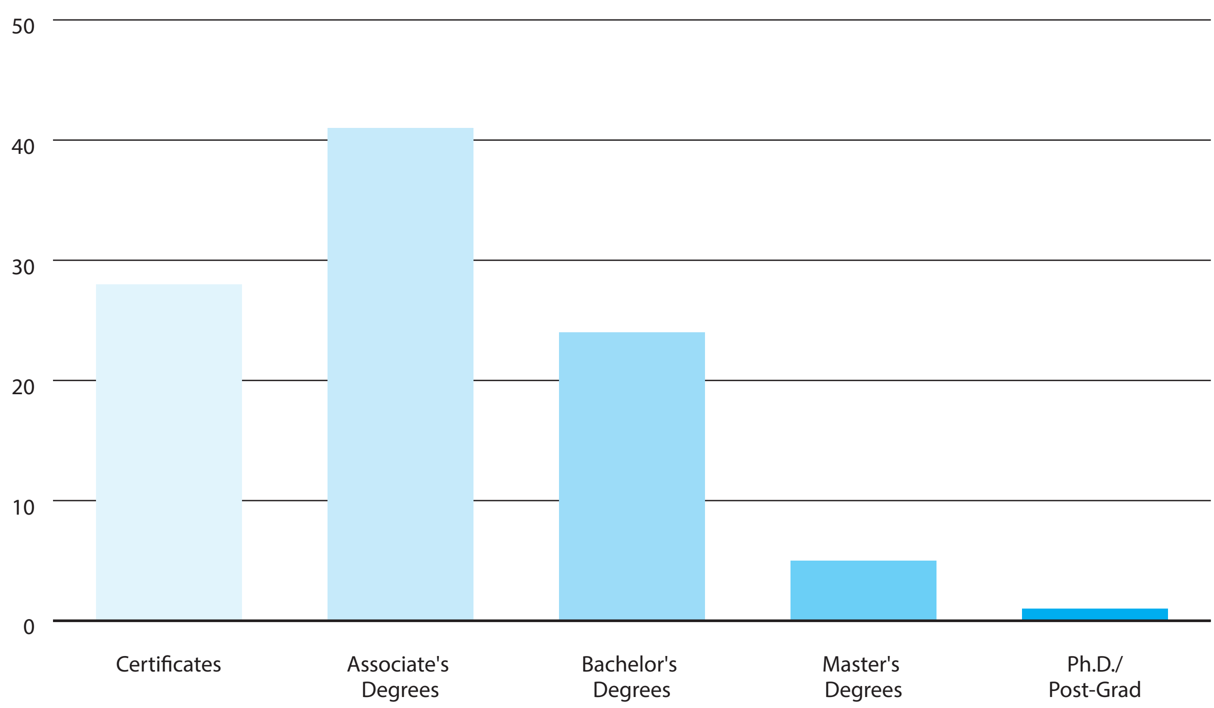
High School Graduation Requirements

Wyoming does not clearly allow computer science to satisfy a core high school graduation requirement in mathematics or science.

Advanced Placement Exams in Wyoming in 2012



Certificates and Degrees in Computer and Information Sciences, and Computer Engineering in Wyoming in 2012



Source: Data calculated from the College Board, AP Data: State Reports (2012). / Source: U.S. Department of Education, National Center for Education Statistics (2012).

References

Aspray, W., Mayadas, F., and Vardi, M. (Eds.). *Globalization and Offshoring of Software*. Association for Computing Machinery (2006). http://www.acm.org/globalizationreport.

College Board. *9th Annual AP Report to the Nation* (2013). http://apreport.collegeboard.org.

College Board. AP Data: State Reports (2012). http://research.collegeboard.org/programs/ap/data/archived/2012.

College Board. AP National Summary Report (2012). http://media.collegeboard.com/digitalServices/pdf/research/2012/National_Summary_12.xls.

College Board. *Advanced Placement Exam Participation* (Research Report 2011-6 2011). http://research.collegeboard.org/sites/default/files/publications/2012/7/researchreport-2011-6-ap-participation-performance-major-choice.pdf.

Computer Science Teachers Association and Association for Computing Machinery. *Bugs in the System: Computer Science Teacher Certification in the U.S.* (2013) (as amended). http://csta.acm.org/ComputerScienceTeacherCertification/sub/CSTA_BugsInTheSystem.pdf. State-by-state results from the report are available at: https://csta.acm.org/ComputerScienceTeacherCertification/sub/StateRequirements.html

Computer Science Teachers Association. *CSTA K-12 Computer Science Standards* (rev. 2011). http://csta.acm.org/Curriculum/sub/K12Standards.html.

Congressional Budget Office. Letter to U.S. House of Representatives Committee on Ways and Means Chairman Charles B. Rangel on the Health Information Technology for Economic and Clinical Health (HITECH) Act (Jan. 21, 2009). http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/99xx/doc9966/hitechrangelltr.pdf.

Exploring Computer Science (ECS). http://www.exploringcs.org.

National Science Foundation. *Community Colleges: Playing an Important Role in the Education of Science, Engineering, and Health Graduates*. (NSF 11-317 2011). http://nsf.gov/statistics/infbrief/nsf11317/.

National Science Foundation. *Science and Engineering Indicators: 2012* (NSB 12-10 2012). http://www.nsf.gov/statistics/seind12/.

National Science Foundation. *Women, Minorities, and Persons with Disabilities in Science and Engineering*. (Special Report NSF 13-304 2013). http://www.nsf.gov/statistics/wmpd/.

President's Council of Advisors on Science and Technology. *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics* (2012). http://www.whitehouse.gov/sites/default/fles/microsites/ostp/pcast-engage-to-excel-fnal_2-25-12.pdf.

U.S. Bureau of Labor Statistics. Current Population Survey: Employed Persons by Detailed Occupation, Sex, Race, and Hispanic or Latino Ethnicity (May 2012). http://www.bls.gov/cps/cpsaat11.htm.

U.S. Bureau of Labor Statistics. Employment Projections 2010–2020. http://www.bls.gov/emp/.

U.S. Bureau of Labor Statistics. National Occupational Employment and Wage Estimates (May 2012). http://www.bls.gov/oes/current/oes_nat.htm.

U.S. Bureau of Labor Statistics. State Occupational Employment and Wage Estimates (May 2012). http://www.bls.gov/oes/current/oessrcst.htm.

U.S. Department of Education. National Center for Education Statistics. Integrated Postsecondary Education Data System (IPEDS) (2012). http://nces.ed.gov/ipeds/.

Wilson, C., Sudol, LA, Stephenson, C., and Stehlik, M. *Running on Empty: The Failure to Teach K-12 Computer Science in the Digital Age*. Association for Computing Machinery and Computer Science Teachers Association (2010). http://www.acm.org/runningonempty/.

Alabama

Press Release, Alabama State Board of Education (Dec. 17, 2013). https://docs.alsde.edu/documents/55/Newsreleases2013/12-12-13%20RIGOROUS%20COMPUTER%20SCIENCE%20COURSES%20NOW%20ACCEPTED%20AS%20CREDIT.pdf.

University of Alabama. Alabama Robotics Competition. http://outreach.cs.ua.edu/robotics-contest/.

University of Alabama. Alabama Summer Computer Camps. http://outreach.cs.ua.edu/camps/.

(continued on next page)

Chicago Public Schools

Chicago Public Schools. http://www.cps.edu.

Chicago Public Schools. Career and Technical Education.
http://www.cps.edu/Programs/Pathways_to_success/CollegeCareer/CTE/Pages/CTE.aspx.

Chicago Public Schools. Graduation Requirements (Sept. 13, 2013).
http://www.cps.edu/SiteCollectionDocuments/PromotionPolicy/HSGraduationReq_English.pdf.

City of Chicago. *The City of Chicago Technology Plan* (2013). http://techplan.cityofchicago.org.

Kentucky

Bluegrass Community and Technical College. Transfer Center.
https://bluegrass.kctcs.edu/en/Transfer_Center.aspx.

Kentucky Community and Technical College System. http://www.kctcs.edu.

Kentucky Community and Technical College System. Transfer Policies and Agreements.
http://www.kctcs.edu/Students/Transfer/Policies_and_Agreements.aspx.

Kentucky Council on Postsecondary Education. Kentucky Virtual Campus (KYVC). Transfer Degrees.
http://www.kyvc.org/transferdegrees.shtm.

Los Angeles Unified School District

Exploring Computer Science. http://www.exploringcs.org.

Los Angeles Unified School District. http://www.lausd.net.

Los Angeles Unified School District. District Profiles.
http://search.lausd.k12.ca.us/cgi-bin/fccgi.exe?w3exec=PROFILE0.

North Carolina

North Carolina Public Schools. http://www.ncpublicschools.org.

North Carolina Public Schools. Career and Technical Education.
http://www.ncpublicschools.org/cte/.

North Carolina State Board of Education. http://stateboard.ncpublicschools.gov.

North Carolina State Board of Education.
Policy Manual, Policies on General Licensure Requirements. (effective June 6, 2013).
http://sbepolicy.dpi.state.nc.us/Policies/TCP-A-001.asp?Acr=TCP&Cat=A&Pol=001.

North Carolina Virtual Public School. http://www.ncvps.org.

Tennessee

Tennessee State Board of Education. Approved High School Courses (rev. July 25, 2013).
http://tn.gov/sbe/Policies/3.205_Approved_High_School_Courses_7-25-13.pdf.

Utah

Utah Exploring Computer Science Initiative.
http://people.westminstercollege.edu/faculty/hhu/ecs/.

Utah State Office of Education. http://www.schools.utah.gov.

Utah State Office of Education. Utah Career Technical Education: Information Technology Education. http://www.schools.utah.gov/cte/it.html.

Washington

Center of Excellence for Information and Computing Technology. http://www.coeforict.org.

Microsoft IT Academy. http://www.k12.wa.us/CareerTechEd/IT-Academy.aspx.

University of Washington. Mathematics Engineering Science Achievement (MESA).
http://depts.washington.edu/mesaweb/.

Washington State Board for Community and Technical Colleges. http://www.sbctc.ctc.edu.

Washington State Board for Community and Technical Colleges. Transfer Policies and Articulation Agreements. http://www.sbctc.ctc.edu/college/e_transfer.aspx.

Washington State Office of Superintendent of Public Instruction. http://www.k12.wa.us.

Washington Workforce Training and Education Coordinating Board. *High Skills, High Wages* (updated Sept. 2012). http://www.wtb.wa.gov/Documents/HSHW2012StrategicPlan.pdf.

Wisconsin

2013 Wisconsin Act 63 (2013) (enacted Dec. 11, 2013).

Association for
Computing Machinery
2 Penn Plaza, Suite 701
New York, NY 10121-0701

www.acm.org pathways.acm.org

Association for
Computing Machinery