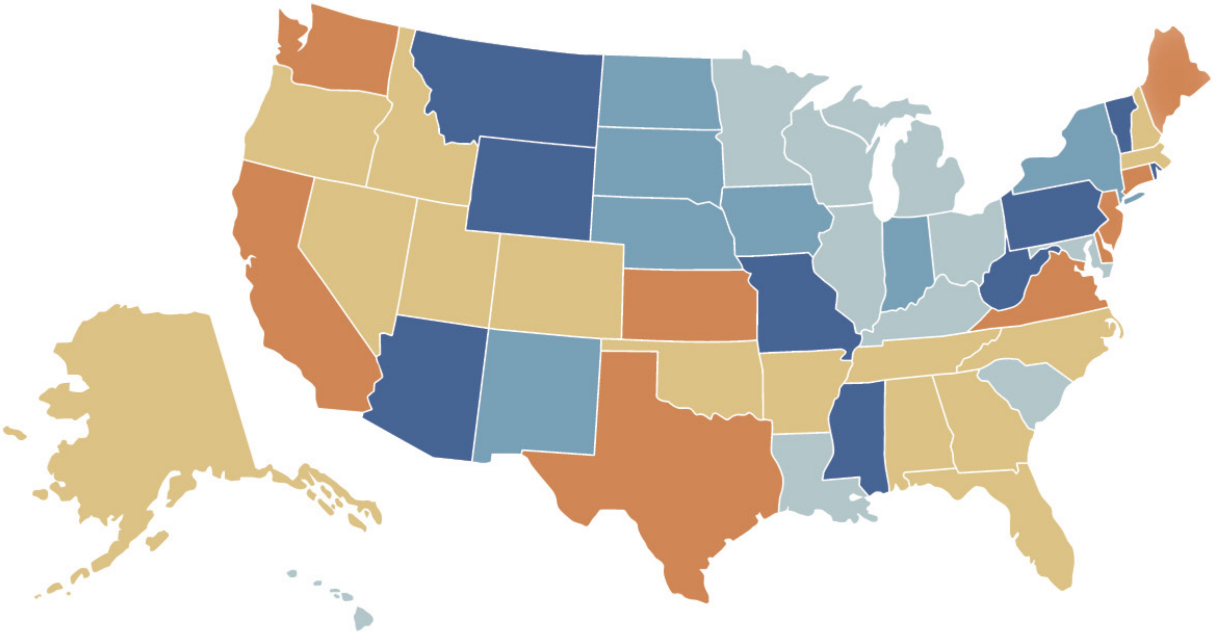


COMPUTING EDUCATION AND FUTURE JOBS:
A Look at National, State, and Congressional District Data

What's the story where you live?

National Center for Women & Information Technology
www.ncwit.org • info@ncwit.org • 303.735.6671

Strategic Partners: NSF, Microsoft, and Bank of America
Investment Partners: Avaya, Pfizer, Merck, and Turner Broadcasting System, Inc.

12162011 Update

1. INTRODUCTION

The U.S. Department of Labor projects that by 2018 there will be nearly 1.4 million computing job openings in the U.S. At current graduation rates and projected annual job openings, only 61% of those jobs could be filled by U.S. computing degree-earners. When including only computing bachelor's degrees, this percentage drops to 29% of projected job openings that could be filled. If we want a workforce that is innovative, competitive, and well-employed, American students need a 21st century computing education. However, rigorous computing is seldom taught in our secondary schools, and currently, too few students study computing at the college level.

While this national picture has been clear for quite some time, state and local data have been more difficult to access. These localized data are important, however, because they can help individuals understand their own areas in order to better advocate for change where they live and work. Toward this end, the National Center for Women & Information Technology (NCWIT) set out to gather key computing education and jobs indicators by state and congressional district. This report, along with its accompanying website (www.ncwit.org/edjobsmap), aims to present these indicators in an easily digestible and accessible format. Individuals can use these data to understand their local situation and to advocate more effectively for changes they would like to see in their schools, colleges, and universities.

2. ABOUT THIS PROJECT

Goals

- Raise awareness about the state of computing education and job opportunities at the national, state, and congressional district levels
- Serve as a benchmark for helping others measure progress at these different levels
- Serve as a resource for advocates and change agents

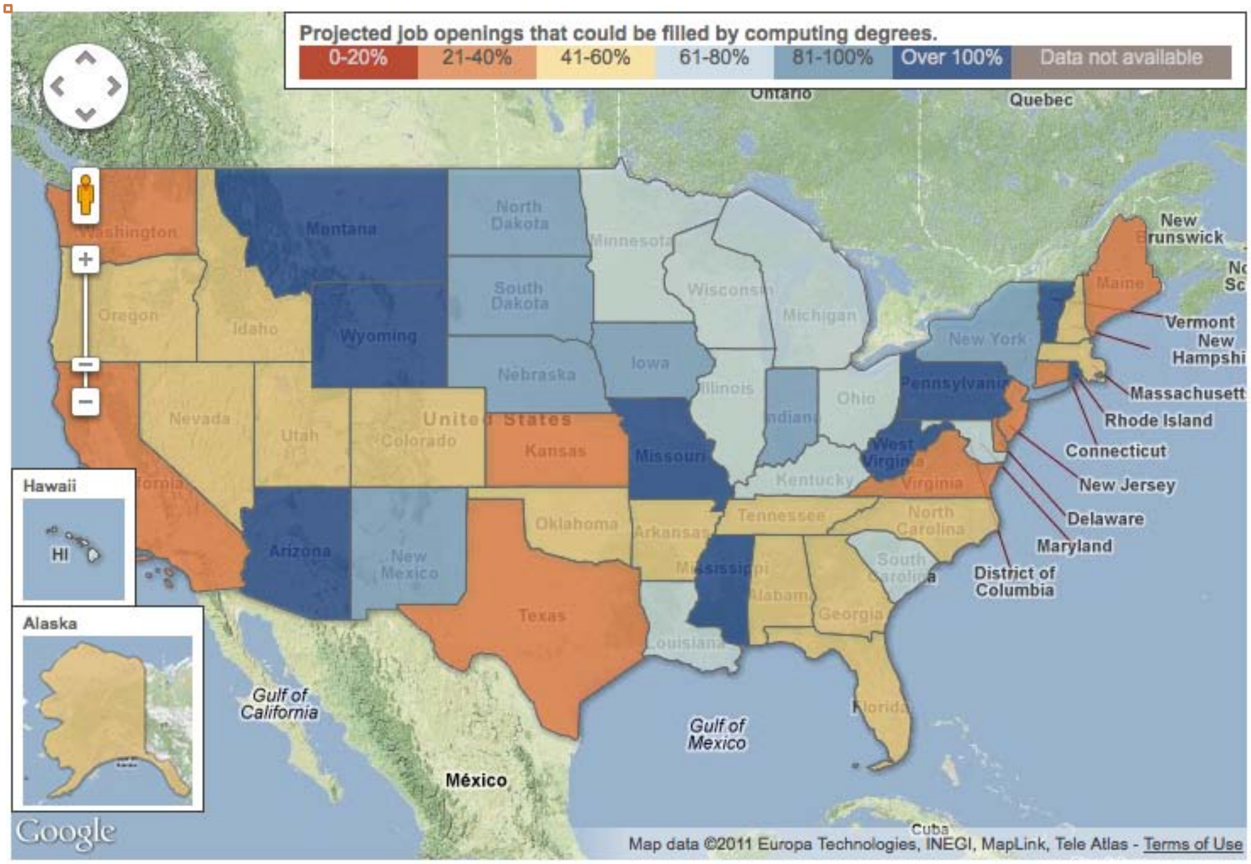
Why congressional districts?

We know that policymakers need data about their own congressional districts in order to advocate for effective computing education legislation and policy, and we have learned that others outside the beltway are also interested in and could use data at this level.

Project Components

Executive Report. This report will give you an overview of what the data suggest and lead you into more specific inquiries of your own, which you can pursue with the interactive map.

Interactive Map Website. For easy access to regionally specific indicators, the data are displayed online as an interactive map (www.ncwit.org/edjobsmap). Viewers can examine not only their own district, but also their state, their neighboring state, and the entire country to understand the fullest picture possible.



Which degrees are counted? Which jobs are considered "computing jobs"?

See Appendix.

3. OBSERVATION HIGHLIGHTS

How many projected computing jobs can be filled by state degree-earners?

Although we know that not all post-secondary degree-earners will remain in-state upon graduation, one useful way to measure an area's preparedness for the economic climate ahead is to compare numbers of graduates with numbers of projected job openings. A look at these indicators in computing[1] suggests that:

- Most states (80%) are producing fewer state degree holders than needed to fill all projected in-state computing-related jobs.
- All states and Washington DC each are producing about one-quarter or more of the computing degree-earners needed to fill the projected computing job openings in that state.[2]
- Twenty states can fill only about one-quarter to one-half of the projected in-state job openings with state-produced degree holders (see Table 1)
- Twelve more states can fill about 60-75% of the computing job openings in that state with state degree holders.

It is important to remember that these imbalances between degrees and job openings could be a function of a number of different factors, including a new or growing technical sector, a relative scarcity of universities or colleges training students in computing, and declining enrollments in computing programs, to name just a few possibilities. A state with a low number of Computer and Information Sciences (CIS) degrees likely needs to improve its computing education, but it also may have a booming technology sector that could never be filled by the schools or universities in that state alone. The indicators in this report can serve as starting point, but the local context is critical for understanding what these data really mean. Raising awareness of these imbalances is the first step toward examining the local context to see why such imbalances are occurring and how the situation might be improved.

[1] In this report, post-secondary degrees included are in Computer and Information Sciences (CIS) at the associate's, bachelor's, and doctoral levels. Projected annual job openings are for Computer and Mathematical occupations, as categorized by the U.S. Bureau of Labor Statistics.
[2] The average annual number of openings refers to the average number of openings per year during the 10-year projection period; this number includes both growth and replacement job openings.

Table 1. States that can fill from about ¼ to ½ of projected computing job openings with state degree-earners

State	Percent of jobs that could be filled	Average annual computing job openings	CIS degrees earned, 2007-2008 academic year
Connecticut	24%	1993	480
Texas	31%	12,770	3900
Delaware	32%	533	169
Virginia	32%	10,888	3493
New Jersey	33%	5210	1709
California	36%	20,950	7484
Washington	37%	4433	1622
Maine	39%	255	99
Kansas	40%	1374	551
Alaska	43%	117	50
Arkansas	45%	1061	481
Idaho	47%	613	287
Massachusetts	47%	5080	2380
Oklahoma	50%	1250	630
Oregon	51%	1136	580
Alabama	51%	1870	958
Tennessee	51%	1765	905
Colorado	52%	3385	1749
Utah	53%	2120	1116
Georgia	54%	4660	2511

Ten states are producing more degree-earners than there are projected job openings (Table 2). Note, however, that the actual number of job openings differs markedly from state to state and may not actually reflect robust job growth. Wyoming, for instance, is producing more than enough CIS degree-earners, in part, because it is only projected to have 50 average annual job openings.

Table 2. States that can fill 100% or more of projected computing job openings with state degree-earners

State	Percent of jobs that could be filled	Average annual computing job openings	CIS degrees earned, 2007-2008 academic year
Iowa	100%	1310	1306
Pennsylvania	101%	4936	4989
Missouri	103%	1815	1862
Mississippi	111%	400	445
Wyoming	120%	50	60
Rhode Island	123%	455	560
Vermont	129%	232	299
Arizona	266%	1744	4646
Montana	359%	243	872
West Virginia	122%	330	402

There are several reasons a state might produce more CIS degrees than the state's projected job openings, including but not limited to the following:

- The state could be doing well in producing computing degree-earners.
- There might be a large university in that state but a very small or nearly non-existent tech sector.
- There might be an online university (e.g., University of Phoenix) where people from all over the country earn degrees; these degrees are counted within that state even though the students do not live or work there.
- The actual numbers of degrees and jobs for any given state might be very small. For instance, a university may be producing just 20 degrees in computing per year; if there are only 10 annual computing job openings in that state, the state is producing over 100% of the degree-earners needed to fill those jobs.

Again, investigating the local context is critical for determining the reasons for overages. It is also important to consider overages in terms of the larger national picture. States with overages are not producing enough extra degree holders to fill the open jobs in other states.

How many projected computing jobs can be filled by degree-earners in congressional districts?

Most congressional districts are producing less than half of the computing degree-earners needed to fill the computing job openings projected for their surrounding metropolitan areas. On the other hand, one in five districts (20%) is oversaturated with computing graduates compared to projected metro area job openings, most notably Utah-3, California-18, California-20, Indiana-9, and Pennsylvania-5. Nearly all of the districts producing these kinds of overages have very few technical jobs in their districts. For example, in the above districts with the highest overage percentages, Utah-3 has 20 annual computing job openings projected, CA-18 has six openings and CA-20 has six openings, ID-9 has 41 openings, while PA-5 has 87 openings.

As with the states, districts with overages are not always producing enough extra degree-earners to fill the other open jobs in other districts in that state. Knowing the local context is important for understanding shortages and overages in any given district. Considering these imbalances within the larger state picture is critical.

Which areas are projected to have the most growth in jobs?

All states and Washington DC are expected to see some growth in computing job openings. The rates of growth in computing job openings over the 10-year projection periods vary by state, from a low of 6% to a high of 39%. The average growth in computing jobs in the 50 states and Washington DC is considered to be about 22%; this compares to a 10% growth rate across all occupations. Nineteen states are expected to grow above average. The 10 states with the greatest percent change for projected computing job openings are listed below (Table 3).

Table 3. States with the greatest percent change for projected job openings, 2006-2016

State	Percent change for computing job openings
Utah	39%
Virginia	38%
Arkansas	34%
Illinois	30%
South Dakota	30%
California	29%
Texas	29%
Idaho	28%
Alabama	28%
Mississippi	28%

While the above states may have the fastest-growing overall state rates for computing jobs, some districts or metropolitan areas are projected to grow even faster. Three congressional districts' metropolitan areas (Illinois-4, Arkansas-3, and Georgia-4) are projected to exceed 50%, with Georgia's District 4 expected to see a 71% change.

It is important to note that Georgia is not listed in the top 10 states with the greatest projected percent change. Thus, it is clear that states not included in Table 3 may have fast-growing metropolitan rates even though their overall state growth is not as high. Other metropolitan statistical areas with high projected percent change in computing job openings are located in Arkansas, Georgia, Illinois, Texas, Tennessee, North Carolina, Utah, and Virginia (Table 4).

Table 4. Districts with the greatest percent change for projected computing job openings

District	Percent change for computing job openings
Georgia-4	71%
Arkansas-3	58%
Illinois-4	52%
Illinois-6	46%
Georgia-7	46%
Arkansas-1	45%
Utah-2	45%
Illinois-5	45%
Illinios-7	45%
Tennessee-8	43%
Texas-10	42%
Virginia-10	42%
Virginia-11	42%
Virginia-8	42%
Georgia-3	41%
North Carolina-2	41%

The projected percent change in jobs at both the district and state levels reflects radically varying numbers of actual job openings. For example, as shown in the table above, Illinois-4, projected to see a 52% change in computing job openings through 2016, may have 2,853 annual job openings. Arkansas-3 is expected to see an even higher 58% increase in job openings, but the number of annual computing job openings is projected to be only 476. Because the projected change alone may be misleading, in the next section, we look at the numbers of projected annual computing job openings in more detail.

Which areas are projected to have the most jobs?

It is important to pay attention to the raw numbers of jobs being added, not just percent change. The actual number of average annual job openings projected to occur in each state differs considerably. Consider the following highlights:

- The states projected to have the most job openings in computing are displayed below (Table 5); these10 states are also some of the most highly populated states in the country (i.e., ranked in the top 14 most populated according to U.S. Census data).
- About one-third of states (35%) are projected to have fewer than 1,000 annual computing job openings. The two states with the fewest average annual job openings, Wyoming and Alaska, are projected to have only 50 and 117 openings, respectively.
- About half of states (49%) are projected to have a few thousand job openings.

Table 5. States projected to have the most average annual computing job openings

State	Projected annual computing job openings
California	20,950
Texas	12,770
Virginia	10,888
New York	8120
Illinois	7607
Florida	6830
New Jersey	5210
Massachusetts	5080
Pennsylvania	4936
Georgia	4660

Most metropolitan areas around congressional districts (63% of districts) are projected to have approximately 1,000 computing job openings (Table 6). Four districts are projected to have more than 5,000 computing job openings (California-14 near Silicon Valley and San Francisco; Virginia-8, -10, and -11 near Washington DC).

Table 6. Number of projected annual computing job openings by state and by district

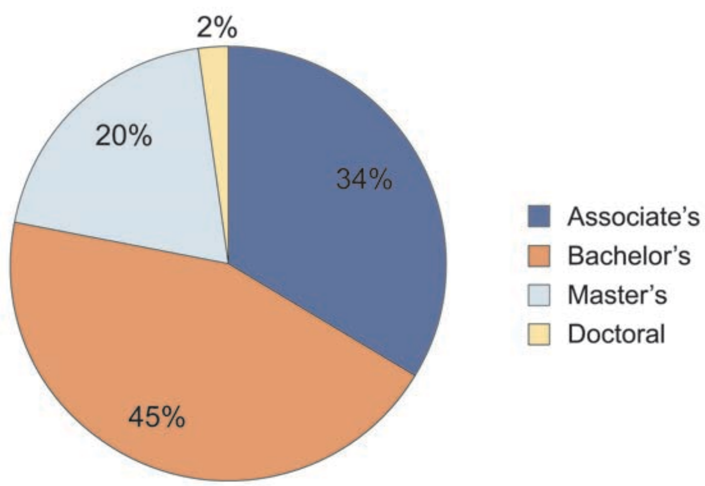
Projected computing job openings	Percent of states	Percent of districts
Less than or equal to 1000	35%	63%
1001-5000	49%	36%
5001-10,000	10%	1%
10,001-21,000	6%	0%

Knowing the percentages of CIS degrees to projected computing job openings is only one piece of the puzzle. The next section examines the CIS degree data more closely.

Which states have produced the most computing degrees?

Over 88,000 CIS associate's, bachelor's, master's, and doctoral degrees were conferred in the U.S. in 2008 (Figure 1).

Figure 1. CIS Degrees completed in the U.S., 2008 (n=88,761)



While every state produced at least some computing degrees, nine states accounted for half of these degrees: Maryland, Virginia, Texas, Florida, Arizona, Pennsylvania, Illinois, New York, and California (Table 7). Not coincidentally, six of these states are among the top nine most-populated states (i.e., California, Texas, New York, Florida, Illinois, and Pennsylvania).[3]

[3] National and State Population Estimates 2008. U.S. Census Bureau, Population Division. (accessed 9-15-11)

Table 7. States producing the most Computer and Information Sciences degrees, 2007-2008 academic year

State	Number of CIS degrees
California	7484
New York	7211
Illinois	5340
Pennsylvania	4989
Arizona	4646
Florida	4007
Texas	3900
Virginia	3493
Maryland	3138
Ohio	3084
Mississippi	2707

The number of degrees produced in each state is the result of a number of factors including the state's overall population as well as the number and type of post-secondary institutions. For example, three of the least-populated states in the nation awarded fewer than 100 CIS degrees (Alaska: 50; Wyoming: 60; Maine: 99).

Which districts have produced the most computing degrees?

The majority of districts' colleges and universities produced between 101 and 500 CIS degrees. The district that produced the most CIS degrees was Arizona-4, where the University of Phoenix-Online is based. This online university alone produced 3,000 CIS degrees in 2008, accounting for most of the district's 3,328 CIS degrees. The other districts producing more than 1,000 CIS degrees are displayed below (Table 8).

Table 8. Districts producing the most Computer and Information Sciences degrees, 2007-2008 academic year

District	Number of CIS degrees
Arizona-4	3328
Illinois-7	1606
Maryland-5	1376
New York-8	1317
Pennsylvania-14	1188
Massachusetts-8	1107

An important contributing factor to post-secondary degree production in any given field is high-school preparation. One suggestive indicator of high-school computing preparation is the number of students who take Advanced Placement (AP) Computer Science (CS) exams. We explore the CS AP exam data in the next section.

How many students are taking Advanced Placement (AP) Computer Science exams?

AP exam participation is one indicator of the robustness of K-12 computer science education. It is particularly important to the future undergraduate student population in computing because research suggests that a significant number of high-school students go on to major in their AP exam field of study.[4]

In 2009, 1.7 million students took the AP exams in the United States. Of the 37 AP exams offered in computing, the CS AP exam ranked 32nd in terms of number of participants. At least one student took the CS AP exam in every single state, and thousands took CS AP exams in the two most populous states – California (2,965) and Texas (3,953). The median number of AP CS exam-takers in each state was 85, while the median number of exam-takers in each state for AP Physics was 669, and for AP Calculus the median was 2,671.

[4] Willingham, W. & Morris, M. (1986). Four years later: A longitudinal study of advanced placement students in college. Princeton, NJ: College Board.

As would be expected, some high-population states far exceeded the median for CS AP exam-takers, while lower-population states had many fewer students take a CS AP exam. In the highly populated states of Florida, Virginia, Maryland, and New York, for instance, more than 1,000 students took the CS AP exam, while in the largely rural states of Montana and Wyoming, there was a combined total of three AP CS-takers. Not surprisingly, Montana and Wyoming also had the lowest number of Physics and Calculus AP exam-takers compared to other states, but the actual numbers of students who took those exams are much higher than the numbers of students who took a CS AP exam: Wyoming had 92 Physics AP exam-takers and 281 Calculus exam-takers; Montana had 47 students taking the Physics AP and 440 taking the Calculus AP that same year. So, even in these two largely rural states, many more high-school students pursued advanced study in other science or math disciplines than in computing.

Not surprisingly, there was a lot of variation in the number of CS AP exam-takers in each district, but about half of districts had from 1 to 50 CS AP exam-takers. Only five districts' CS exam-takers exceeded 500 students (Table 9). All five are located near highly populated metropolitan areas: Virginia-10, Virginia-11, and Maryland-8 are all near Washington DC, while Texas-3 is near Dallas, and Texas-10 is outside of Houston.

Table 9. Districts with the highest number of CS AP Exam-takers, 2009

District	Number of CS AP Exam-takers
Texas-10	711
Virginia-11	647
Maryland-8	598
Texas-3	586
Virginia-10	555

Although there are a number of reasons students might take, or not take, a given AP exam, the relatively low numbers of CS AP exam-takers across the nation and in individual states suggest the need for educational reform if we are to prepare today's students for tomorrow's jobs.

3. CONCLUSIONS

The national story is clear – in the coming years, significantly more computing-related jobs are expected to be available than U.S. graduates with computing degrees. It is, of course, possible that individuals with other degrees can fill some of the projected jobs, but this sort of shifting may require additional training.

The individual state and district stories are not as uniform. Most states (80%) will see a shortage of homegrown degree holders for in-state computing-related jobs. Indeed, at current rates of degree production, twenty states will be able to fill only about half of their projected computing jobs with in-state computing graduates. In contrast, ten states currently produce more degree holders in CIS than anticipated state job openings. These states may have online degree programs that accelerate their production of graduates or brick-and-mortar institutions that draw out-of-state students, but do not necessarily contribute to their in-state educated population, or perhaps, a less developed IT job sector. No matter which direction the mismatch goes, for both state and district data, understanding the local context is essential to anticipating and preparing for what the future will hold for the technology sector.

While the reasons for the disparities between job openings and computing degrees are not always clear, what is clear is the fact that we need to raise awareness about this mismatch and work to improve computer science education throughout most parts of the country. The next section provides examples of how some individuals have already used this information to advocate for change.

4. HOW OTHERS HAVE USED THE MAP DATA TO EDUCATE, INVESTIGATE, AND START CONVERSATIONS

There are a number of ways these indicators can be used to begin conversations that might lead to change that benefits the field of computing. Below are three examples of different ways this localized information has been used.

- A Computer Science faculty member, whose institution is located near a high-tech corridor, examined the AP exam data for congressional districts surrounding his university. He also compared his region's AP exam participation with that of another high-tech region. He took these findings, along with state data, to his congressional representative's office to begin a discussion about improving access to rigorous computer science education in local area high schools. The congressional representative found the comparisons "eye opening."

- A researcher who examines how cultural stereotypes impact people's choices and behaviors used district, state, and national data in her outreach presentations to underscore the need to bring different kinds of people into computing to fill the jobs that are projected to be available in the coming years.
- Two congressional representatives – one of a high-tech district with a major university, and the other with a high minority population and low AP CS exam participation – were motivated by their districts' data to hold a congressional briefing where they presented the national picture as well as their own state and district data. They urged their congressional colleagues to investigate their own local contexts and to take collective action. This briefing preceded the introduction of the Computer Science Education Act.

5. RECOMMENDATIONS, RESOURCES, AND REFORM

Recommendations

Whether or not your area shows a mismatch of talent to jobs, there is no doubt that computer science education at the secondary school level could be improved, or better supported, nearly everywhere, and that the number of students majoring in computing could grow in U.S. colleges and universities. To accomplish this, NCWIT makes several recommendations for curricula and policy:

- **Include computer science classes in local middle and high schools.** Currently, many schools only teach computer literacy – how to use existing software and technologies – rather than computing or computer science. Computer science involves learning how to create new technologies.
- **Improve teacher preparation and professional development.** Expand teacher certification requirements to include computer science. Provide professional development for teachers who teach, or would like to teach, computer science.
- **Make computing courses accessible for all.** Recruit students at both the secondary and post-secondary levels who are underrepresented in computer science and use inclusive pedagogies in these courses.
- **Implementing engaging curricula.** Use hands-on, interactive, and engaging teaching practices in computing and computer science courses, particularly in introductory courses. This is important at all levels: elementary, secondary, and postsecondary. Research-based practices and curricula are available from NCWIT and the Computer Science Teachers Association (see resources below).

- **Allow computer science coursework to count toward high-school graduation.** Students' schedules are overcrowded, making electives difficult. Allowing students to count computer science courses as math or science graduation credit would increase its attractiveness to high-achieving students.

Useful Resources

Get started now. Check out the story where you live by visiting NCWIT's interactive map that displays all the data contained in this report – by nation, state, and congressional district (www.ncwit.org/edjobsmap).

In addition, NCWIT and its partners have a number of materials available for free that can help you improve computing education at all levels – whether you are a policymaker, a teacher, a department chair, or simply an interested community member.

NCWIT Resources for Raising Awareness

- **Moving Beyond Computer Literacy: Why Schools Should Teach Computer Science.** This "talking points" card helps individuals explain the difference between computer science and computer literacy and make the case for improving computer science education in local school districts. (www.ncwit.org/schools)
- **Why Should Young People Consider Careers in Information Technology?** This "talking points" card helps adults talk with youth about why they should consider technology jobs. (www.ncwit.org/youngwomen)
- **By the Numbers.** This one-page resource provides key statistics about the state of computing education and jobs in the nation. (www.ncwit.org/bythenumbers)
- **NCWIT Scorecard.** This booklet – with accompanying PowerPoint slide decks – shows trends in girls' and women's participation in computing and computing-related professions in the U.S. over time, providing a benchmark for measuring progress and identifying areas for improvement. (www.ncwit.org/scorecard)
- **Research-based practices for using inclusive, engaging curriculum.** NCWIT has collected and published a wide array of research-based practices that can help to recruit and retain students and professionals in the field of computing (www.ncwit.org/practices).

Reform Efforts

NCWIT and its partners are also involved in other efforts that are aimed at improving the awareness of the issues and bolstering computing education. These include:

- **Computer Science Education Act**. This key legislative initiative is part of a continuing effort to address the growing crisis in K-12 computer science education. The legislation will bolster computer science education programs across the country, and help ensure that the education pipeline will produce the workforce the nation will need to thrive and compete in the 21st century. (http://www.acm.org/press-room/news-releases/2011/csea/view)
- **Association for Computing Machinery (ACM)**. ACM, the world's largest educational and scientific computing society, delivers resources that advance computing as a science and a profession. ACM provides the computing field's premier Digital Library and serves its members and the computing profession with leading-edge publications, conferences, and career resources. See especially the Running on Empty Report, which details the state of computer education today (http://www.acm.org/runningonempty).
- **Computing in the Core.** Computing in the Core is a non-partisan advocacy coalition of associations, corporations, scientific societies, and other non-profits seeking to elevate the national profile of computer science education in K-12 within the U.S. and work toward ensuring that computer science is one of the core academic subjects in K-12 education. (http://www.computinginthecore.org)
- **Computer Science Education Week** (December 4-10, 2011). CS Ed Week is a call to action to share information and offer activities that will advocate for computing and elevate computer science education for students at all levels. (http://www.csedweek.org)
- **Transforming High School Computer Science**. The CS / 10,000 Project is backed by a consortium of partners, including government agencies, community groups, private foundations, and industry leaders, to train and install 10,000 teachers in 10,000 schools by 2015. (http://opas.ous.edu/Committees/Resources/Publications/NSF_AP_CS_10000ProjDesc.pdf)
- **Counselors for Computing (C4C)**. A four-year campaign, C4C empowers school counselors to increase student interest in and preparedness for computing and technology jobs. C4C brings school counselors the information and resources they need to advise students about careers in computing and technology and paths to these careers. (www.ncwit.org/c4c)

- **CS Principles: Redesigning the CS AP Exam**. Computer Science: Principles is a new course under development that seeks to broaden participation in computing and computer science. Development is being led by a team of computer science educators organized by the College Board and the National Science Foundation. (http://www.csprinciples.org)
- **Computer Science Teachers Association (CSTA)**. The CSTA Leadership Cohort consists of trained teacher leaders from each state who advocate for K-12 computer science education. CSTA provides many curricular and advocacy resources. (http://csta.acm.org)

6. APPENDIX: METHODOLOGY AND DATA LIMITATIONS

Which degrees are counted?

NCWIT collected the number of degrees conferred at all levels – associate's, bachelor's, master's, and doctorates. The Computer and Information Sciences (CIS) category used by the National Center for Education Statistics includes a number of computing degrees: Computer and Information Sciences, Artificial Intelligence and Robotics Information Technology, Computer Programming, Data Processing, Computer Systems Analysis, Data Entry/Microcomputer Applications, Word Processing, Computer Science, Computer Software and Media Applications, Web Page, Digital/Multimedia and Information Resources Design, Data Modeling/Warehousing and Database Administration, Computer Graphics, Modeling, Virtual Environments and Simulation, Computer Software and Media Applications, Computer Systems Networking and Telecommunications, Computer/Information Technology Administration and Management, System Administration/Administrator, System, Networking, and LAN/WAN Management/Manager, Computer and Information Systems Security, Web/Multimedia Management and Webmaster, Information Technology Project Management, and Computer Support Specialist.

Which jobs are considered "computing jobs"?

Computing jobs include all jobs that fall under the U.S. Department of Labor category "computer and mathematical occupations." The Department of Labor primarily includes the following jobs in this category: systems analysts, computer scientists, software engineers, computer programmers, network systems and data communications analysts, network and computer systems administrators, database administrators, and computer support specialists. Mathematical occupations comprise only a small number of the jobs in this category. The average annual number of openings refers to the average number of openings per year during the 10-year projection period; this number includes both growth and replacement job openings.

Data-collection Methodology

The education and workforce data were collected from a variety of sources and then compiled in-house by NCWIT researchers. All copy-paste, Excel formulae, and manually typed-in data were checked by someone other than the original analyst. In addition, all source data for the map were checked against the final spreadsheets.

Education Indicators

The AP exam data were available by state, while the degree completions had to be derived based on zip code. All district-level education data were derived from matches with a zip code-congressional district equivalency file NCWIT had purchased as a custom order from analysts at the Higher Education Research Institute (HERI) housed at the University of California at Los Angeles. This equivalency file showed which zip codes fell into which districts around the nation. If a zip code fell into more than one district, it was included in each related district.

AP Exam-takers

- **State Level.** State-level AP exam-taker data were taken directly from the College Board Website. To give the fullest picture of CS exam interest, both CS A and CS AB exam takers were summed. (http://www.collegeboard.com/student/testing/ap/exgrd_sum/2009.html)

- **District Level.** NCWIT purchased a custom-made district-level dataset from College Board. College Board used the zip code-district equivalency file NCWIT provided them. NCWIT researchers decided that states with only a single congressional district should be represented by state data rather than district data, since the state data were likely more reliable and were already shared publicly on the College Board Website.

Degree Completions

- **State Level.** The completed degree data for CIP 11 (Computer and Information Sciences) were taken from the 2007-08 National Center for Education Statistics (NCES) Integrated Postsecondary Education Data System (IPEDS), based on zip code of institution. NCWIT purchased a custom-made file of degree completions by zip code from NCES. Using the zip code-district equivalency file (described above), NCWIT researchers assigned degrees to each state based on state zip codes listed on the Brainy Zips Website (http://www.brainyzip.com/). Zip codes were then assigned to states using Microsoft Excel functions. For Guam, Puerto Rico, and Virgin Islands, data were downloaded according to the whole territory rather than by zip code, since they are not divided by district.
- **District Level.** Using the degree by zip code file, degrees associated with each zip code were assigned via Excel functions to a congressional district. Data for a given zip code were included in a district's sum if the zip code was located at all in that district. Some data associated with certain zip codes were, therefore, counted more than one time.

Workforce Indicators

Computing jobs include all jobs that fall under the U.S. Department of Labor category "computer and mathematical occupations." While the national projection data are based on 2008-2018, individual states update their data at different rates, so when this research was conducted, some states had published projection data for 2002-2012, while others had data for 2004-2014; most had data for 2006-2016 or 2008-2018. The projections NCWIT researchers used were the most up-to-date data available at the time of data collection.

- **State and District Level.** Both state and district workforce data were taken from State Department of Labor Websites (http://www.bls.gov/oco/oco20024.htm) or the State Occupational Projections Website (http://www.projectionscentral.com/). Data gathered included: Annual Openings for Computing, Percentage Change for Computing, and Total Projected Increase in Jobs for Computing. The computing data were gathered from the overarching variable named "Computer and Mathematical Occupations." Some states don't provide data for annual openings; therefore, annual openings were calculated using the total openings in the 10-year period.

- **District Level.** Because occupational projections by congressional district are not available, regional data were used (e.g., Metropolitan Statistical Area (MSA), Workforce Development Area (WDA), counties, etc.). To determine which regions were included in a congressional district, comparisons were made between state congressional district maps and the regional maps used in the projections. Often a particular county or MSA might be part of more than one district; similarly, one district may include several counties or MSAs. In these cases, decisions to include a county or MSA were made using a combination of criteria. First, we considered the percentage of a county or MSA that was included in a district. Generally, if more than 30% of the regional workforce area was included in a district, that regional area was included. Exceptions were made, however, for mitigating circumstances. These were determined on a case-by-case basis. For example, we would ask if a county or MSA had a substantial business sector where people from this district would likely travel to go to work. If so, we would include it even if only a small portion of it actually fell in that particular congressional district. Once the districts were matched with projection areas, calculations were then performed based on the resulting projection data. For more information on which regions were included in a district, send inquiries to: info@ncwit.org.

Limitations of the Data

There are some limitations to these indicators and to the datasets that underlie them. These are listed below.

- Because none of these datasets were available by congressional district, the district-level data had to be approximated. Thus no district data – whether education or workforce – can be summed to equate a larger whole, such as a metropolitan area or state.

- All of the education data are based on zip code, and some zip codes cross more than one congressional district; thus, the district total is often an overestimate of exams taken or degrees completed.
- It is not possible to determine the home zip code of students graduating with CIS degrees; therefore, the completed degrees data refers to all degrees completed at degree-granting two- and four-year institutions located in that district. This means that districts without colleges or universities will show low numbers in this dataset even though some students living in these districts may graduate from nearby universities.
- Sometimes a single congressional district falls into more than one Metropolitan Statistical Area (MSA), Workforce Development Area (WDA), county, or other regional statistical area. Conversely, one regional workforce area can contain several districts. Due to these overlaps, summing the jobs data for different districts will not yield an accurate number for a larger geographical region. Similarly, summing the number of jobs in a state's districts will not match the state job numbers. Because district workforce data are based on the surrounding metro area jobs data, the data may be exactly the same for neighboring congressional districts.

There are also a number of contextual factors that, if available, would shed even more light on the issues of educational preparedness and future computing job openings. Some of these include:

- Further contextualization for state and district data, including norming degree completions and job openings to area population, or to population density
- A better understanding of the relationship between AP exams and the local educational curricula and resources, and between AP exams and completion of degrees in a given field
- The likelihood of undergraduate and graduate students to stay in the state in which they received their degrees, and how that might differ by field of study and level of degree
- The homegrown vs. domestically-imported composition of the technical workforce around the country.