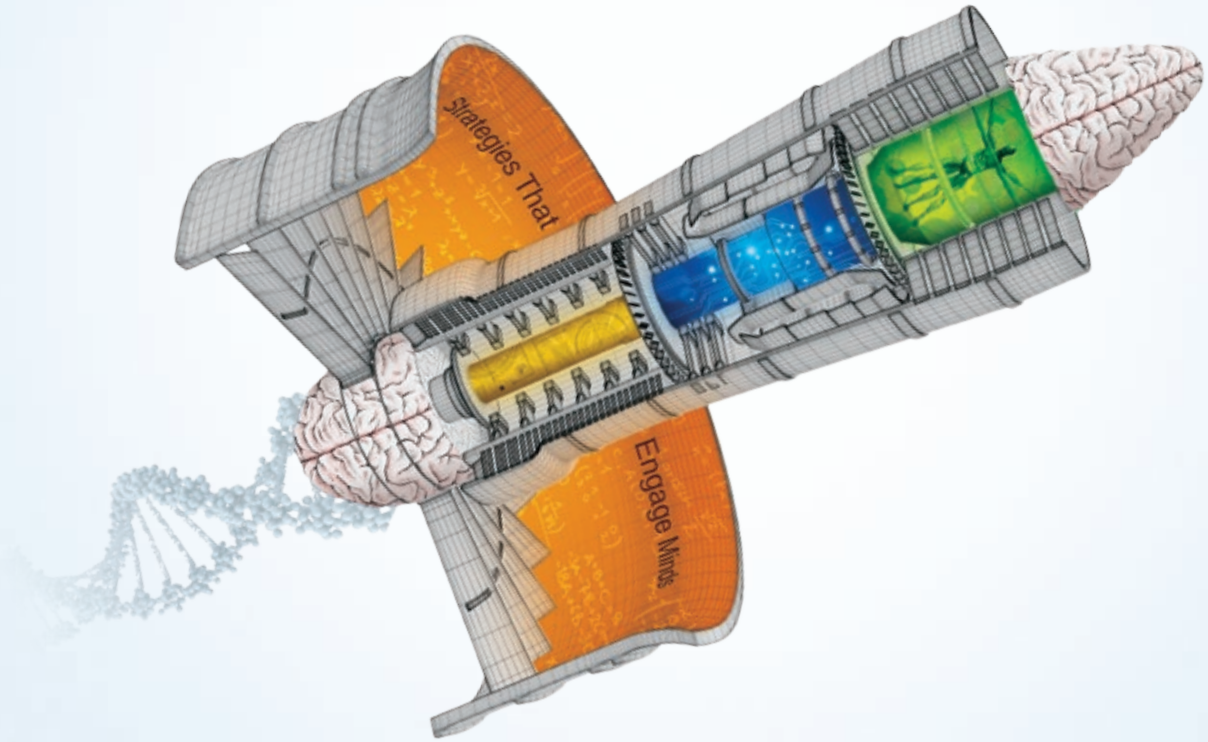
Strategies That Engage Minds®

Empowering North Carolina's Economic Future



SMT
North Carolina Science, Mathematics, and Technology Education Center

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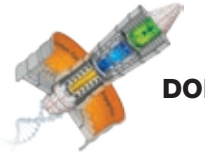

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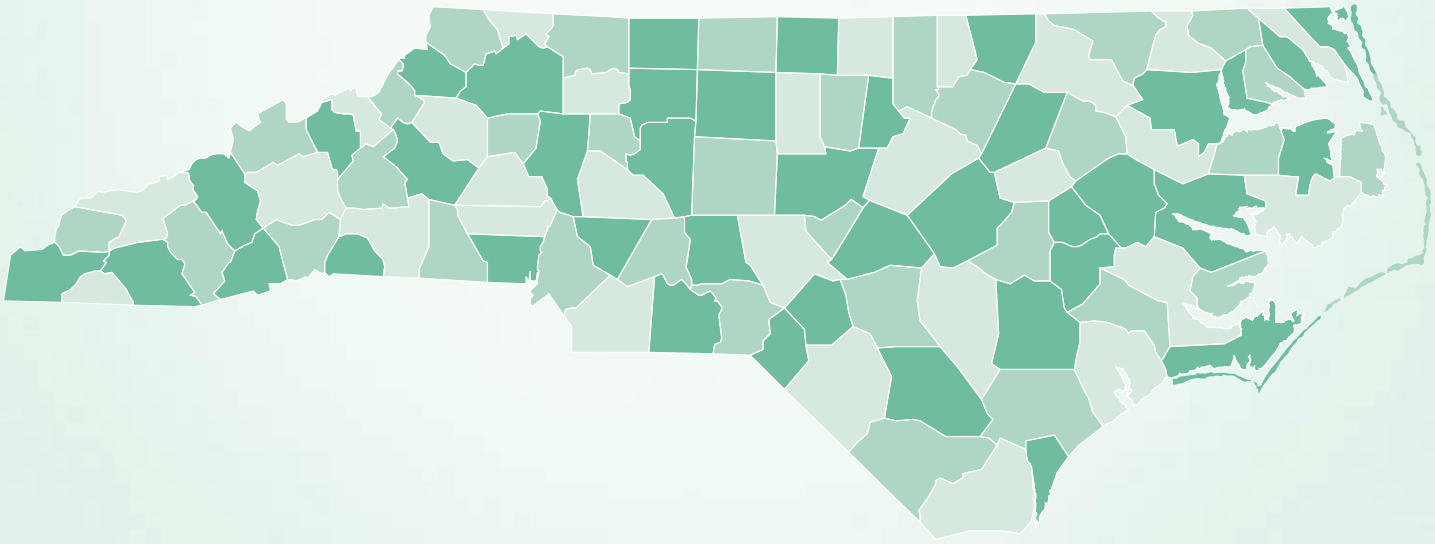
North Carolina: The Shape of its Change

A Preface to the NC STEM Scorecard



By

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Like a teenager seemingly transformed from adolescence to near-adulthood by a growth spurt—make that two spurts—North Carolina has emerged as a mega-state, more metropolitan and more ethnically diverse than ever. It remains distinctly North Carolina, but two decades of dramatic population growth have reshaped its civil society, its economy and its identity.

From 1990 to 2000, the state grew from 6.6 million people to slightly more than 8 million, a growth rate of 21.4 percent.[1] From 2000 to 2010, North Carolina added another 1.5 million people, increasing the population to 9.5 million, a growth rate of 18.5 percent, the sixth highest rate among the states.[2]

The U.S. Census Bureau estimates that the state's population rose to 9.75 million in 2012. The N.C. Office of State Budget and Management projects the statewide population to rise to 10.6 million in 2020, and 11.5 million in 2029.[3]

While population measurement serves as an indicator of a state's relative robustness and attractiveness, public policy must be responsive to the components of growth or decline. Thus, demographic shifts affect policymaking on all elements of education, particularly STEM (science, technology, engineering and mathematics), not to mention all other public service domains: health, housing, transportation and social services. Key areas affected by the state's population increase are discussed in detail below.

Growing older

North Carolina's near-term future will be largely influenced by the aging of the Baby Boom generation—people born between 1946 and 1964.[4] The leading edge of this generation began reaching the customary retirement age of 65 in 2011, and the bulge will grow steadily larger until approximately 2030 when the projected 1.9 million surviving members of the Baby

9,750,000

The U.S. Census Bureau estimates that the state's population rose to 9.75 million in 2012. The N.C. Office of State Budget and Management projects the statewide population to rise to 11.5 million in 2029.

[1,2] Author's analysis of US Census Bureau, Census 1990 and 2000: Summary File 1.
[3] NC Office of State Budget and Management, "Annual Estimates of the Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2012 (by Selected Age Groups for the United States, States, and Puerto Rico: July 1, 2011 (NST-EST2012-01)," last revised December 2012.
[4] www.census.gov/popest/data/state/totals/2012/tables/NST-EST2012-01.xls.
[5] NC Office of State Budget and Management, "North Carolina Population by Age, 2030-2032," last revised January 28, 2013. www.osbm.state.nc.us/ncosbm/facts_and_figures/socioeconomic_data/population_estimates.shtm.

By 2029, people between the ages of 25 and 54 will represent a smaller share of the overall population than they do now—a projected 37.4 percent, down from today's 41.3 percent.

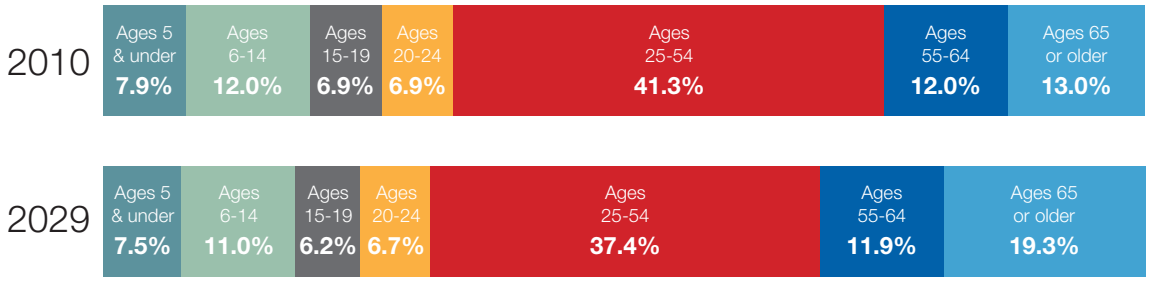
Boom cohort residing in North Carolina will be between the ages of 66 and 84.[5]

Currently, 25 percent of the state's 9.7 million people are 55 years and older. By 2029, according to projections, 31.2 percent of the state's 11.5 million people will be 55 and older (see figure below).[6]

In 2029, today's 9- and 10-year-olds—young people already well into elementary school—will be entering the prime-age workforce. At that time, people between the ages of 25 and 54 will represent a smaller share of the overall population than they do now—a projected 37.4 percent, down from today's 41.3 percent.[7] While productivity gains can easily allow a relatively smaller number of working-age people to support a larger number of non-workers, the future age composition of North Carolina's citizenry will differ from the current one.

In terms of age, younger members of the population are headed for a relatively small-scale decline as a share of the whole. The number of pre-school-aged children is projected to drop from 7.9 percent to 7.5 percent. Similarly, the number of K-12 and college-aged young people is expected to decline by one percentage point or less. [8] The population will grow, but the youth cohort will not be significantly different than now.

Projected Changes in the Age Composition of the North Carolina Population 2010-2029



Source: NC Office of State Budget and Management, Population Projections, October 2012.

[6] Lindsay Howden and Julie Meyer, Age and Sex Composition: 2010 (Washington, DC: U.S. Census Bureau, 2011), 2, www.census.gov/prod/cen2010/briefsc2010br-03.pdf.

[7,8] NC Office of State Budget and Management, "North Carolina Population by , 2030-2032," last revised January 28, 2013.

Growing Multi-Ethnic

The Baby Boom generation, now heading toward retirement, is a largely white cohort. Among North Carolinians age 55 and older, more than three out of four are white. In the prime working ages, more than six out of 10 are white (see figure below).[9]

While the state will remain majority-white for the foreseeable future, North Carolina already has become a multi-racial and multi-ethnic society. Today, 65 percent of North Carolinians are non-Hispanic whites, 22 percent are black, 8.6 percent Hispanic, and the rest are Asian, American Indian and people who report themselves as two or more races.[10]

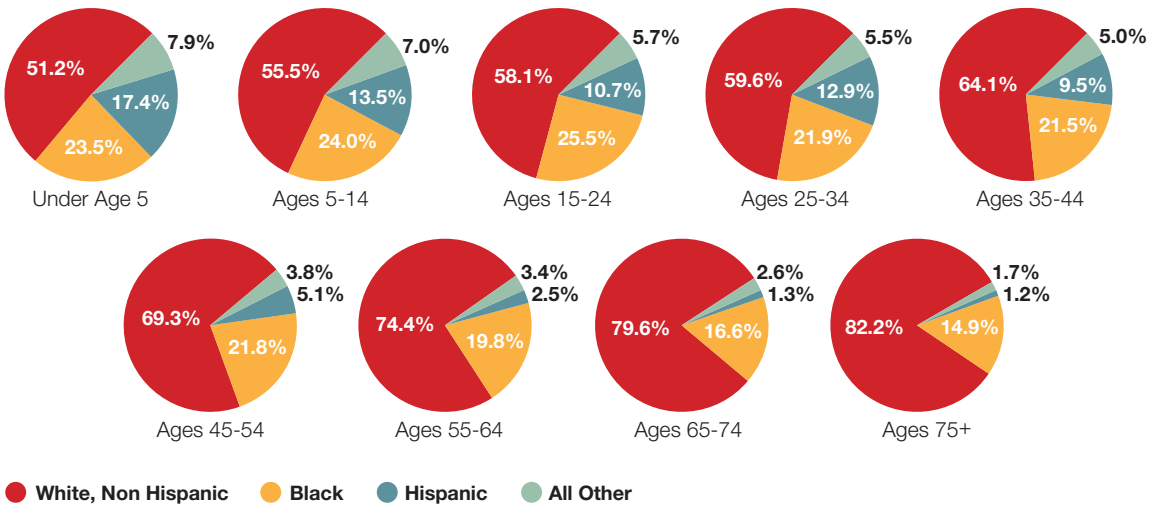
The rising generation of North Carolinians consists primarily of black and Latino citizens. Among school-age residents, fewer than six out of 10 are white, while blacks and Latinos represent more than three out of 10. Asians, American Indians and others also make up a discernible portion of the non-white population.[11]

North Carolina's pre-school-aged population already is evenly mixed: 51 percent white and about 50 percent persons of color and non-white ethnic groups.[12] The black and Hispanic populations are somewhat younger than the white population, likely due to higher birthrates, i.e., natural population increases among minority groups regardless of immigration trends in the future.

Like most other states in the country, North Carolina has significant gaps in educational attainment between racial and ethnic groups.[13] If North Carolina is to increase overall educational attainment, it must place a particular focus on degree completion and job certification by blacks and Hispanics, who will constitute a major segment of the workforce in the near future.

The rising generation of North Carolinians consists primarily of black and Latino citizens. Among school-age residents, blacks and Latinos represent more than three out of 10, while fewer than six out of 10 are white.

Racial / Ethnic Composition of North Carolina's Population by Age 2011



Source: US Census Bureau, American Community Survey, One-Year Estimates, 2011.

[9] NC Office of State Budget and Management, "North Carolina Population by , 2030-2032," last revised January 28, 2013.
[10-13] Author's analysis of U.S. Census Bureau, American Community Survey, One-Year Estimates, 2011.

55%

By 2029, if population projections hold, the 15 most-populous North Carolina counties will account for an even greater share of the state's residents—up to 55 percent or more.

Growing metropolitan

Today's North Carolina has been formed not only by the scale of its growth but also by the geographical realignment of its population from rural to urban. In 1950, when North Carolina had 4 million people, 32 cities and towns each had more than 10,000 residents, and nine municipalities had more than 30,000 people. Only one city, Charlotte, had more than 100,000 people.[14]

By 2010, some 4.88 million people—more than half the state's population—lived in the 15 most populous counties (see table below).[15] The state has become increasingly defined by its three major metropolitan areas: the Triangle, Triad and greater Charlotte, each a sprawling mix of city, suburb, exurb and rural patches.

By 2029, if population projections hold, the 15 most populous counties will account for a greater share of the state's residents—more than 55 percent. The two most populous counties, Wake and Mecklenburg, are projected to be the home of more than one out of five North Carolinians.[16]

Population data tell only part of the metro story. Metropolitan areas are the engines of the North Carolina economy in terms of both economic output and employment:

* Fully 83 percent of the state's gross domestic product comes from the state's 14 metropolitan statistical areas, as defined by the US Office of Management and Budget.[17] Of the metro areas, the Triangle (Raleigh, Durham, and Chapel Hill) and the Charlotte region rise well

Total Population of 15 Most Populous Counties in North Carolina

in 2000 and 2010 (Actual) and 2020 and 2029 (Projected)

	2000 (Actual)		2010 (Actual)		2020 (Projected)		2029 (Projected)	
County	**Number**	**Share**	**Number**	**Share**	**Number**	**Share**	**Number**	**Share**
Mecklenburg	695,454	8.6%	919,628	9.6%	1,094,997	10.3%	1,249,383	10.8%
Wake	627,846	7.8%	900,993	9.4%	1,096,426	10.3%	1,267,208	11.0%
Guilford	421,048	5.2%	488,406	5.1%	545,706	5.1%	596,326	5.2%
Forsyth	306,067	3.8%	350,670	3.7%	380,495	3.6%	401,713	3.5%
Cumberland	302,963	3.8%	319,431	3.3%	340,638	3.2%	342,974	3.0%
Durham	223,314	2.8%	267,587	2.8%	304,081	2.9%	335,942	2.9%
Buncombe	206,330	2.6%	238,318	2.5%	276,994	2.6%	308,907	2.7%
Gaston	190,365	2.4%	206,086	2.2%	220,188	2.1%	232,170	2.0%
Union	123,677	1.5%	201,292	2.1%	237,255	2.2%	267,801	2.3%
Cabarrus	131,063	1.6%	178,011	1.9%	236,786	2.2%	267,856	2.3%
Johnston	121,965	1.5%	168,878	1.8%	218,021	2.1%	251,624	2.2%
Pitt	133,798	1.7%	168,148	1.8%	205,039	1.9%	228,857	2.0%
Davidson	147,246	1.8%	162,878	1.7%	198,084	1.9%	223,652	1.9%
Iredell	122,660	1.5%	159,437	1.7%	187,719	1.8%	204,977	1.8%
Catawba	141,685	1.8%	154,358	1.6%	171,866	1.6%	180,239	1.6%
Subtotal	**3,895,481**	**48.4%**	**4,884,121**	**51.2%**	**5,714,295**	**53.8%**	**6,359,629**	**55.2%**
N.C.	8,049,313		9,535,483		10,614,862		11,528,737	

Sources: US Census Bureau, 2000 and 2010 Census, Summary File 1; and NC Office of State Budget and Managment, Population Projections, October 2012.

[14] A useful compilation of research reports about the achievement gap in North Carolina was available at www.ncpublicschoools.org/aer/achievement.

above the others. The Charlotte region (which includes Rock Hill and its environs in South Carolina) accounted for 27 percent of the North Carolina GDP in 2010. The Durham-Chapel Hill and Raleigh-Cary regions (divided into two metro areas by the Office of Management and Budget) combined to produce 23 percent of the state's GDP. In contrast, non-metro North Carolina produced just under 17 percent of GDP.[18]

* Data from the Labor and Economic Analysis Division of the NC Department of Commerce show that the three major metropolitan areas produce jobs for half of the state's workforce. Of the roughly 4 million jobs in the state in 2011, 2.2 million were located in the Triangle, Triad and Charlotte metro areas.[19]
* Department of Commerce data also show that the three major metropolitan areas are home to half of the state's labor force, with 2.4 million people residing in the Triangle, Triad and Charlotte metro areas.[20]

Growing Importance of Place

A strong indicator of the Triangle and the Charlotte region as the powerful magnetic pole of the state's economy is their power to attract and retain college-educated in-migrants between the ages of 25 and 39. A recent study by scholars at Portland State University (Oregon) found that Charlotte and Raleigh-Durham both ranked in the nation's top 15 metro areas in attracting and retaining young, college-educated migrants. And the appeal of these two metro areas has greatly increased since 1980 with the steady and diverse labor market.[21]

Over the past decade or so, scholars have engaged in a lively round of inquiries over the interaction between a place's quality of life and its economic vitality. Early in the Internet era, it was argued that the ease of communication would allow more and more people to work at locations of their own choosing—at home or elsewhere, detached from the "home office." Evidence now suggests that people in high-tech, high-skill, and high-wage enterprises want to live and work near each other to facilitate day-to-day exchanges of ideas. Richard Florida, a noted urbanist at the University of Toronto, has argued that economic growth depends on the clustering of "creative workers," who many localities are attempting to attract by cultivating amenities and cultural resources. In his recent book, *The New Geography of Jobs*, Enrico Moretti, an economist at the University of California, Berkeley, responds that localities need first to build "a solid economic base" to become more attractive. In his book, *Triumph of the City*, Edward Glaeser, an economist at Harvard University, points out that talented people, being mobile, will seek out "good places to consume as well as produce"—and he suggests that the amenities that matter most are "safe streets and good schools for their children."

83% of North Carolina's gross domestic product comes from the state's 14 metropolitan statistical areas, as defined by the US Office of Management and Budget.

[15] Ferrel Guillory, "North Carolina's Future: Population and Policy." Presentation to the North Carolina Center for the Advancement of Teaching, July 2012.
[16] Author's analysis of U.S. Census Bureau, Census 2010: Summary file 1.
[17] NC Office of State Budget and Management, "Annual County Population Totals: Estimates and Projections, July 1, 2010 – July 1, 2029," last revised October 2012.
[18] As of February 13, 2013, a map of North Carolina's metropolitan statistical areas was available at www2.census.gov/geo/maps/metroarea/stcbsa_pg/Nov2004/cbsa2004_NC.pdf.
[19] Author's analysis of U.S. Bureau of Economic Analysis, GDP by State and Metropolitan Area, 2010.
[20] Author's analysis of North Carolina Department of Commerce, Labor and Economic Analysis Division, Current Employment Statistics, 2011.
[21] Jason Jurjevich and Greg Schrock, *Is Portland Really the Place Where Young People Go to Retire? Migration Patterns of Portland's Young and College-Educated, 1980-2010* (Portland, OR: Portland State University, 2012), 1-2, http://mkn.research.pdx.edu/wp-content/uploads/2012/09/JurjevichSchrockMigrationReport1.pdf.Statistics, 2011.

Selected Economic Indicators for Metropolitan Statistical Areas in North Carolina, Ranked by GDP by Metropolitan Area

MSA	GDP by State (2010)			Labor Force (2011)			Payroll Employment (2011)		
	Value (Millions of Chained 2005 $)	Share of Statewide Total	Cumulative Share	Annual Avg Number (Seasonally Unadjusted)	Share of Statewide Total	Cumulative Share	Annual Avg Number (Seasonally Unadjusted)	Share of Statewide Total	Cumulative Share
Charlotte-Gastonia-Rock Hill, NC-SC	$103,402	27.2%	27.2%	896,004	19.3%	19.3%	826,700	21.1%	21.1%
Raleigh-Cary	$51,629	13.6%	40.7%	582,688	12.5%	31.8%	508,600	13.0%	34.0%
Durham-Chapel Hill	$35,547	9.3%	50.1%	264,996	5.7%	37.5%	273,500	7.0%	41.0%
Greensboro-High Point	$30,911	8.1%	58.2%	372,155	8.0%	45.5%	341,700	8.7%	49.7%
Winston-Salem	$20,090	5.3%	63.5%	243,060	5.2%	50.7%	205,200	5.2%	55.0%
Fayetteville	$15,259	4.0%	67.5%	164,547	3.5%	54.2%	130,700	3.3%	58.3%
Wilmington	$12,309	3.2%	70.7%	182,058	3.9%	58.1%	136,700	3.5%	61.8%
Asheville	$12,272	3.2%	73.9%	215,314	4.6%	62.8%	169,600	4.3%	66.1%
Hickory-Lenoir-Morganton	$10,007	2.6%	76.6%	170,620	3.7%	66.4%	143,000	3.6%	69.7%
Jacksonville	$7,265	1.9%	78.5%	67,412	1.4%	67.9%	47,600	1.2%	71.0%
Greenville	$5,671	1.5%	80.0%	93,460	2.0%	69.9%	74,900	1.9%	72.9%
Rocky Mount	$4,857	1.3%	81.2%	72,201	1.6%	71.4%	59,000	1.5%	74.4%
Burlington	$3,934	1.0%	82.3%	72,416	1.6%	73.0%	57,400	1.5%	75.8%
Goldsboro	$3,505	0.9%	83.2%	54,658	1.2%	74.2%	43,000	1.1%	76.9%
Subtotal	**$316,658**	**83.2%**	**83.2%**	**3,451,589**	**74.2%**	**74.2%**	**3,017,600**	**76.9%**	**76.9%**
Nonmetro NC	$63,973	16.8%	16.8%	1,202,322	25.8%	25.8%	904,800	23.1%	23.1%
NC	**$380,631**	**100.0%**	**100.0%**	**4,653,911**	**100.0%**	**100.0%**	**3,922,400**	**100.0%**	**100.0%**

Sources: US Bureau of Economic Analysis, GDP by State and Metropolitan Area, 2010; and North Carolina Department of Commerce, Labor and Economic Analysis Division, Local Area Unemployment Statistics and Current Employment Statistics, 2011.

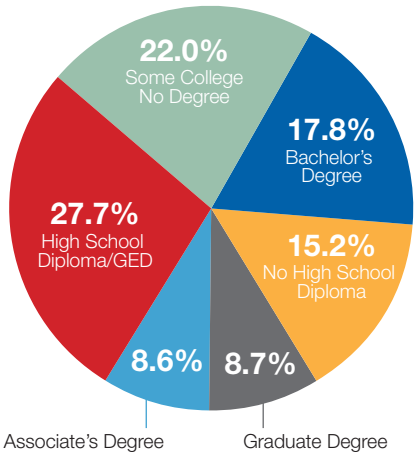
North Carolina has benefitted from high rankings on many indices achieved by the Research Triangle region and the Charlotte metro area. Even so, quality of life varies from place to place, and from one person's tastes and aspirations to another's. The Gallup Poll regularly publishes rankings of the "well-being" of states—arriving at a score that averages six indices of life evaluation, emotional health, physical health, healthy behavior, work environment, and basic access to insurance. In the 2012 Gallup rankings, North Carolina scored 65.7, just below the national score of 66.7, and about mid-way between the highest (71.1) and lowest (61.3) scores.

To be sure, quality of life is a complex intersection of many variables, including access to health care, cost of housing, recreational opportunities, and proximity to mountains, seashore and other natural features. In today's economy, place matters, and schools, colleges and universities rank high in defining the quality of places.

Growing More Educated

Due to both population growth and major efforts in education, North Carolina has made significant gains in educational attainment over the past two decades. The proportion of North Carolina adults without a high school diploma has dropped dramatically from 30 percent in 1990 to 15 percent in 2010. In the same period, the state made steady gains in the attainment of associate's, bachelor's and graduate degrees (see figures at right and below).[22] In a recent paper, Peter Coclanis and Dan Gitterman, professors at the University of North Carolina at Chapel Hill, point out that "the total share of the population with some level of education beyond high school [is] 57.1 percent" (see figure below).[23]

Highest Level of Educational Attainment in North Carolina, Adults Ages 25 and Older 2010

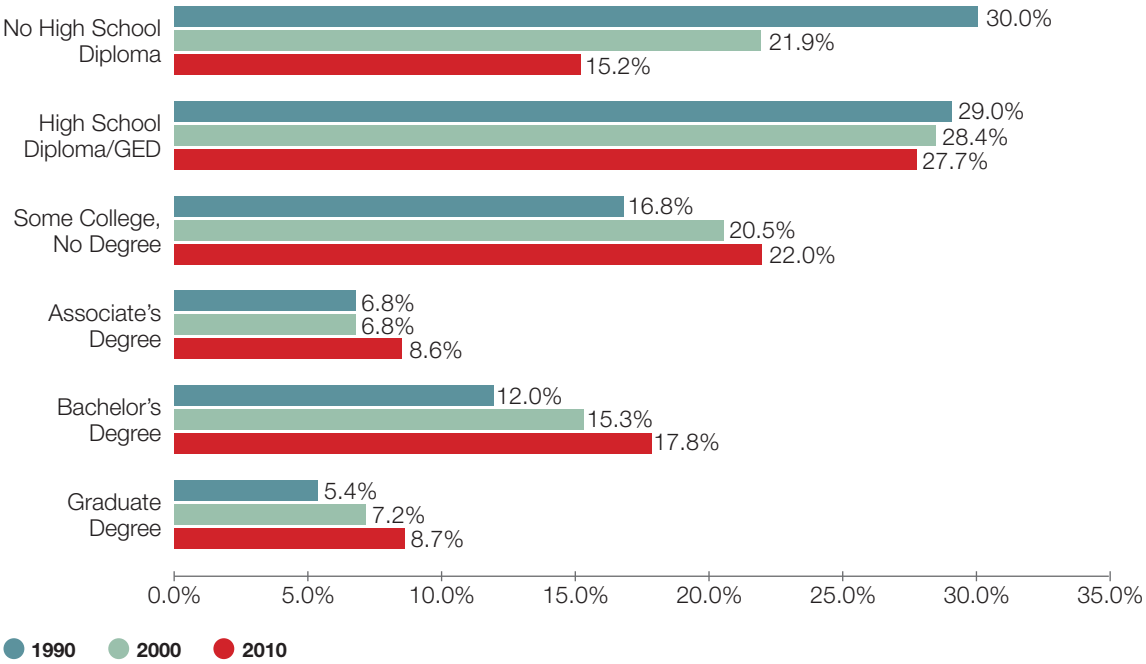


Source: US Census Bureau, American Community Survey, One-Year Estimates, 2010. Global Research Institute analysis.

15%

The share of North Carolina adults without a high school diploma has dropped dramatically from 30 percent in 1990 to 15 percent in 2010.

Changes in Highest Level of Educational Attainment in North Carolina Adults Ages 25 and Older 1990, 2000 and 2010



Source: US Census Bureau, Decennial Census, 1990 and 2000; and American Community Survey, One-Year Estimates, 2010. Global Research Institute analysis.

[22] Author's analysis of US Census Bureau, Census 1990 and 2000; and US Census Bureau, American Community Survey, One-Year Estimates, 2010.

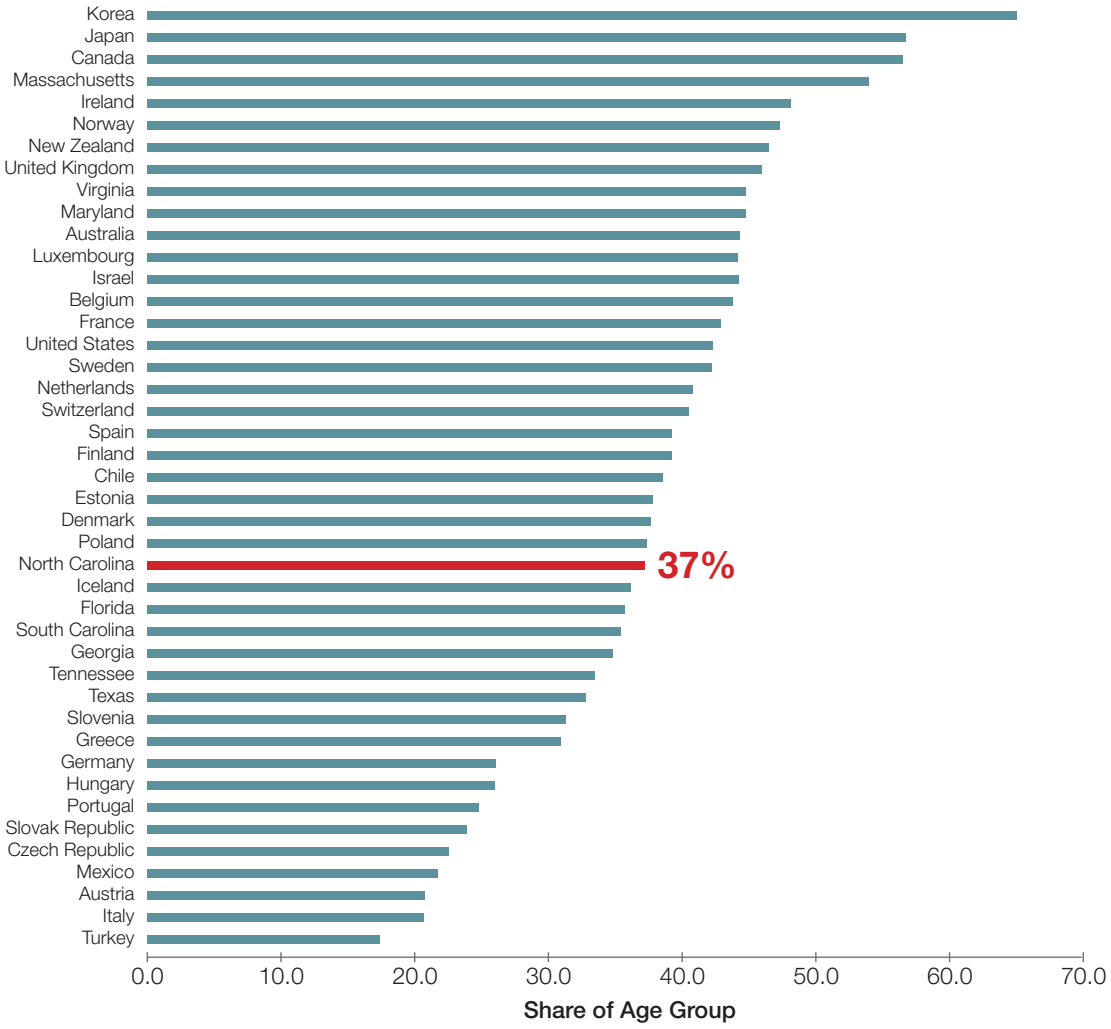
[23] Daniel Gitterman and Peter Coclanis, *Moving Beyond Plato Versus Plumbing: Individualized Education and Career Passways for All North Carolinians* (Chapel Hill, NC: UNC Global Research Institute, 2012), 8, http://gri.unc.edu/files/2012/09/GRI-Plato_vs_Plumbing-Sept-2012.pdf.

37%

Slightly more than 37 percent of North Carolina 25- to 34-year-olds possess a postsecondary degree. Among 35- to 44-year-olds, the percentage with postsecondary degrees is nearly 40 percent.

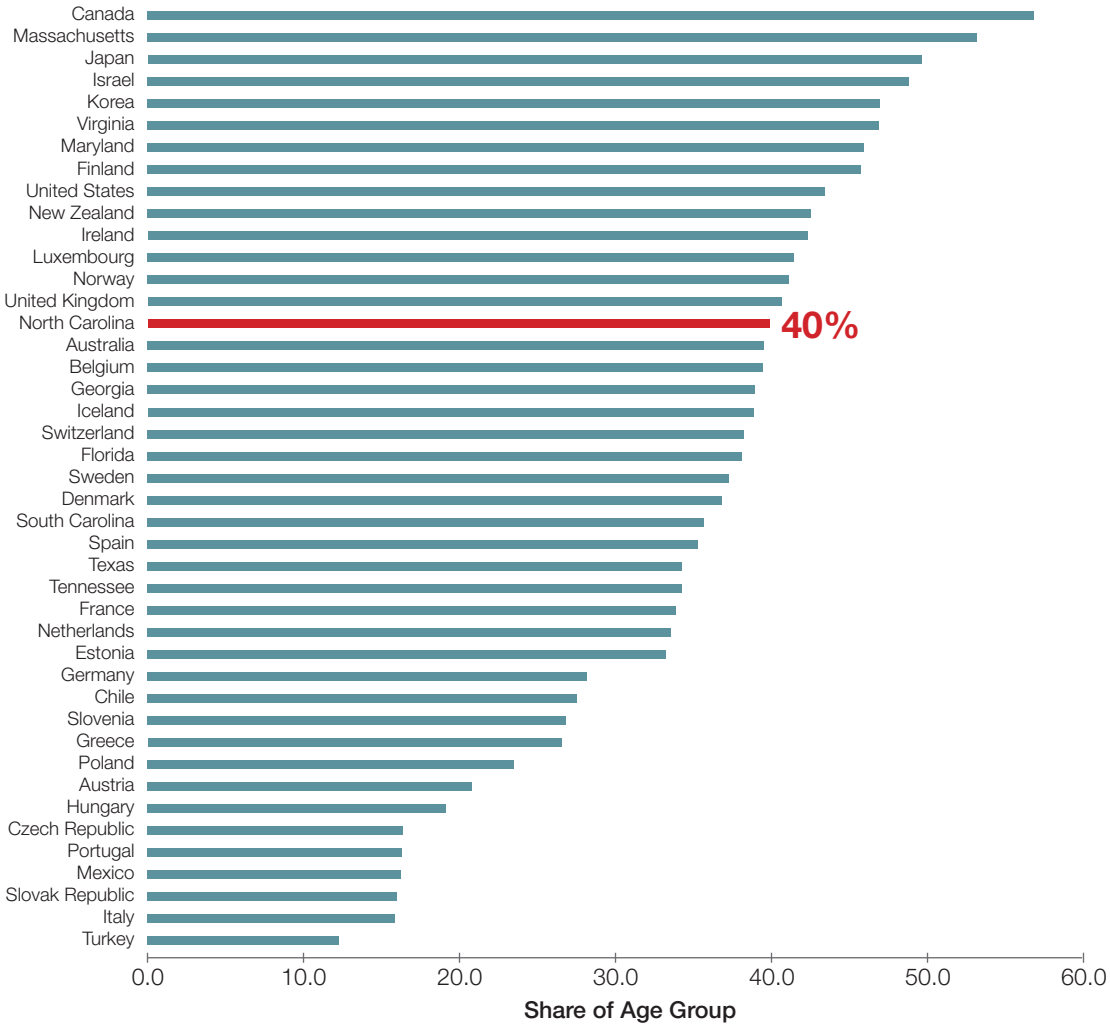
Still, North Carolina ranks below the nation, as well as several major industrial nations, in its share of young and mid-career adults with "tertiary education"—that is, an associate's, bachelor's or graduate degree. The following figures combine data from the Organisation of Economic Cooperation and Development (OECD), an international policy forum to which most rich nations belong, and the U.S. Census Bureau's American Community Survey to show that slightly more than 37 percent of North Carolina 25- to 34-year-olds possess a postsecondary degree. The U.S. as a whole ranks below Korea, Canada, Japan, New Zealand and the United Kingdom. In this measurement, North Carolina falls below its neighbor Virginia, at nearly 45 percent, and below the U.S. level of 42 percent, but North Carolina ranks higher than Texas, Georgia and other Southern states. Among 35- to 44-year-olds, North Carolina ranks somewhat higher, at nearly 40 percent, though still below the levels of Virginia and the U.S. as a whole.

Share of Persons Ages 25-34 with Tertiary Education, OECD Countries and Selected American States 2010 or Latest Available Year



Source: OECD Factbook 2013 and American Community Survey, One-Year Estimates, 2010.

Share of Persons Ages 35-44 with Tertiary Education, OECD Countries and Selected American States 2010 or Latest Available Year



Source: OECD Factbook 2013 and American Community Survey, One-Year Estimates, 2010.

91%

Between 2005 and 2010, 91 percent of job growth in North Carolina was in the service sector industries.

Growing Apart Economically

The two recessions of the 2000-10 decade together had a profound effect on both North Carolina's economy and population. While some people, places and sectors continue to rise and thrive, the state gave up many of the gains it had made during the economic expansion of the 1990s. In several respects, North Carolina has a bifurcated economy, at once both rising and falling.

In the 2011 North Carolina Economic Index—the most recent available—the state Department of Commerce reported: "Over the past five years, ten of the twenty super-sectors measured have gained industry employment and ten have lost employment. In general, the changes have led to a transition away from the state's traditional, labor intensive, production-oriented, 'blue collar' industries to more of a service and knowledge-based 'white collar' economy. Between 2005 and 2010, 91 percent of job growth has been in the service sector industries. Meanwhile, manufacturing industries have accounted for 56 percent of job losses."[24]

Job losses have been especially heavy in manufacturing groups related to textiles and furniture. Job gains have come in both high-end and low-end manufacturing. For example, between 1990 and 2008, pharmaceutical and medicine manufacturing ranked first in net employment gain with nearly 10,000 jobs, followed closely by animal slaughter with nearly 9,000 net jobs.[25]

As a result of the 2007-09 recession and its lingering aftermath, unemployment in North Carolina has remained stubbornly above the national rate. Unemployment has risen in the state among people at every level of educational attainment. And yet, attainment still matters, in aggregate, in terms of being employed. The unemployment rate for North Carolinians without a high school diploma rose to 15.2 percent in 2011, to 11.9 percent for high school graduates without further education, to 7.5 percent for people with some college, compared to 5.1 percent for adults with a bachelor's degree or higher.[26]

Distinct differences also exist in unemployment along the lines of gender, race and ethnicity. Over the course of 2011, the unemployment rates for white men and white women hovered around 8 percent. Unemployment among black residents, meanwhile, was significantly higher—23 percent for men, 15.7 percent for women. The jobless rate for Hispanic women was 13.9 percent, and for Hispanic men in the range of 7.2 to 9.5 percent.

For a short time in the 1990s, North Carolina's poverty rate dipped below the national rate (see figure at right). But poverty spiked upward in the state during both the 2000-01 and 2007-09 recessions, leaving North Carolina with a slightly higher rate of poverty than the nation.[27]

A similar trend is evident in median household income. In the mid-1990s, North Carolina matched the nation in median household income, but the achievement proved short-lived (see figure at right). As national income continued to rise, North Carolina's household income leveled off, then dropped during the past two recessions. Now there is a substantial gap between North Carolina and the nation in median household income.[28]

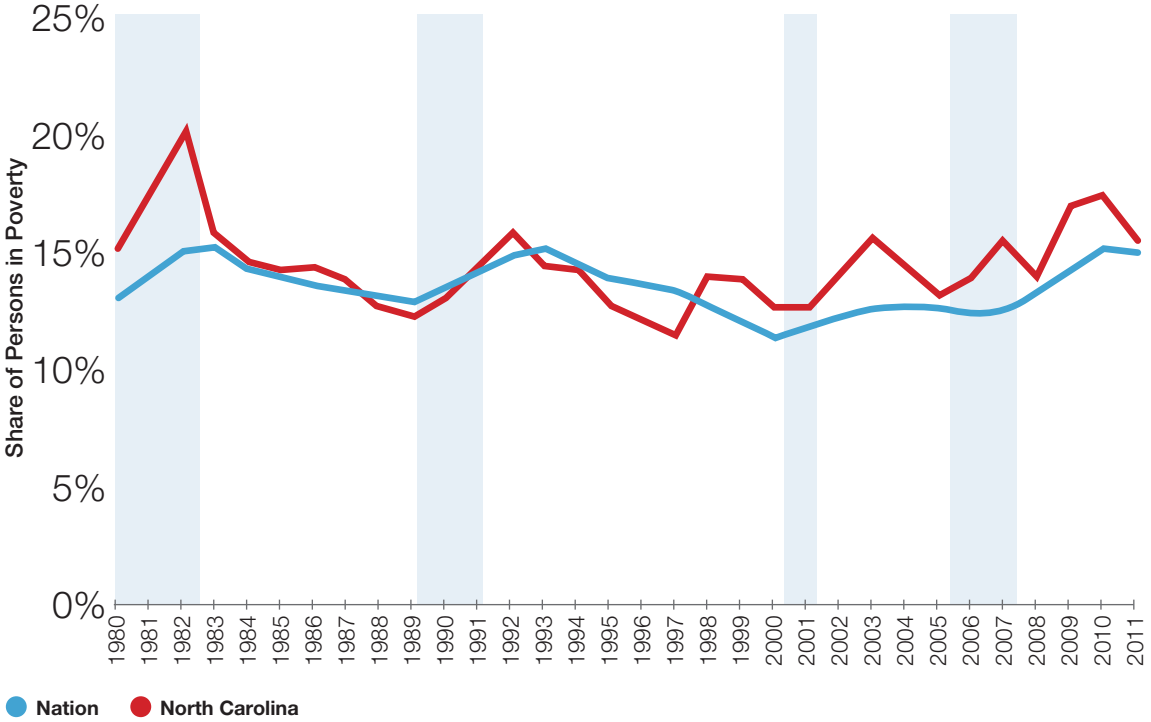
[24] Policy Research and Strategic Planning Division, 2011 *North Carolina Economic Index: A Summary of North Carolina's Economic Strengths, Challenges, and Opportunities* (Raleigh, NC: NC Department of Commerce, 2011), 18, www.nccommerce.com/LinkClick.aspx?fileticket=fDdSEfUsxTE%3D&tabid=41&mid=5338.

[25] Institute for Emerging Issues, Data Presented to emerging Issues forum, Raleigh, NC February 2013.

[26] Author's analysis of U.S. bureau of Labor statistics, Geographic Profile of Employment and Unemployment, 2011.

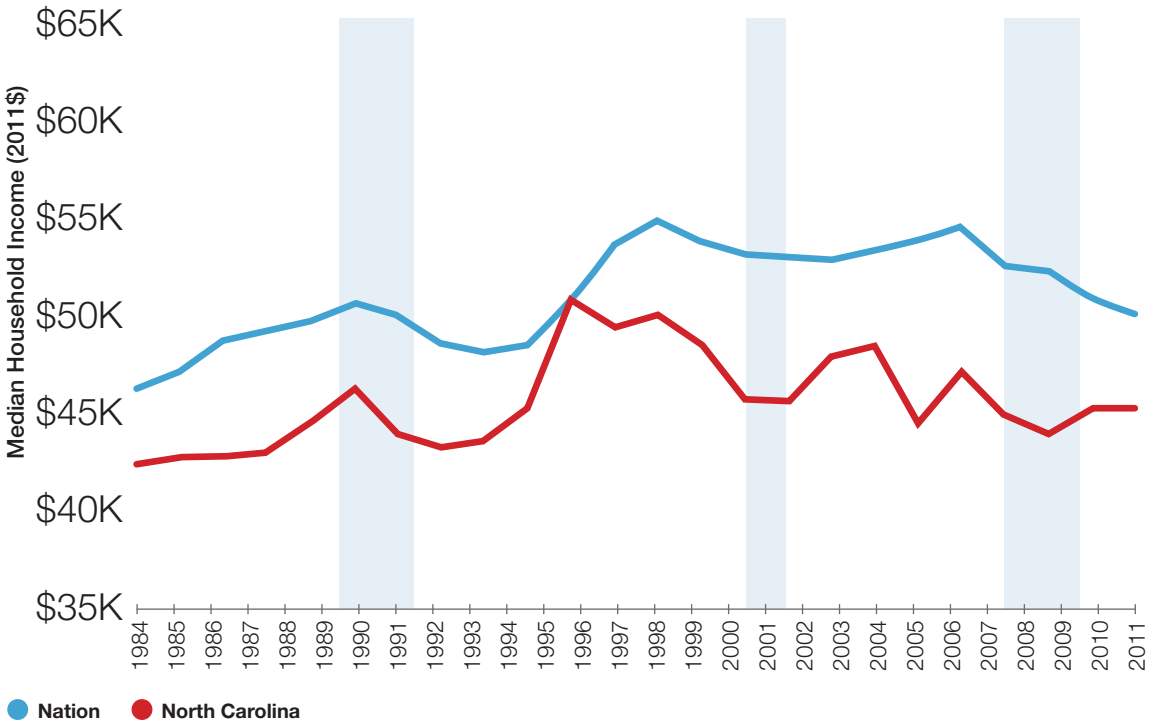
[27,28] Author's analysis of US Census Bureau, Current Population Survey, Annual Social and Economic Supplement, various years.

Poverty Rates (Persons) in the United States and North Carolina 1980-2011



Notes: Shared boxes denote national recession years. Source: US Census Bureau, Current Population Survey, Annual Social and Economic Supplement.

Median Household Income in Inflation-Adjusted Dollars (2011), United States and North Carolina 1984-2011



Notes: Y-axis doesn't start at zero to better show change. Shared boxes denote national recession years. Note missing values for 1993, 1995, 1997, and 1999. Inflation adjustment made with CPI-RS. Source: US Census Bureau, Current Population Survey, Annual Social and Economic Supplement.

What is the STEM ScoreCard for North Carolina?

North Carolina stands at a crossroads in its economic and educational development. The proud, traditional businesses that fueled our economy in the past, especially those requiring minimal skills and education, are playing a diminishing role in our state. A new fast-paced economy is emerging that requires higher levels of knowledge and skills based in science, mathematics, engineering and technology achieved through strategies that engage the mind. Are we ready?

North Carolina is not alone in experiencing a STEM-related transformation in its economy. It is happening throughout the United States and around the globe. The new economy is fast changing and very competitive. North Carolina's future is at the intersection of readiness and direction: Are we prepared to compete? What direction do we take from here?

The NC STEM ScoreCard has been developed as a tool to help the public and decision makers chart a direction for the state's STEM-related economic future. The ScoreCard offers a comprehensive assessment of where we stand across a number of "domains" that are important in setting the direction for change in North Carolina.

More than one hundred people and organizations have contributed to the development of this first-ever NC STEM ScoreCard. They helped craft it, provided data, and will be impacted by the decisions that flow from those who examine and take actions on the recommendations.

The North Carolina Science, Mathematics, and Technology Education Center (SMT Center) has been charged with the responsibility of developing this ScoreCard. The Center believes that STEM education is more fully captured by the phrase *Strategies That Engage Minds*™—the title of this ScoreCard. This definition of STEM education underlies the rationale for the indicators selected for this comprehensive STEM assessment. While the ScoreCard Project Team has sought to create a credible tool, we are also confident that this first-ever North Carolina STEM ScoreCard is not yet a perfect instrument, so we encourage comments and suggestions that can improve the ScoreCard and its impact.

North Carolina's STEM-related economic future is at the crossroad of readiness and direction: Are we prepared to compete? What direction do we take from here?

Stem Defined

STEM is the acronym for science, technology, engineering and mathematics. This adaptation of the National Research Council definition of the four STEM subjects is as follows:

* **Science** is the study of the natural world, including the laws of nature associated with physics, chemistry, and biology and the treatment or application of facts, principles, concepts, or conventions associated with these disciplines.
* **Technology** comprises the entire system of people and organizations, knowledge,

STEM education, in its most complete sense, should embrace not only formal education but also engagement in informal learning through outdoor experiences, visits to science museums, zoos, aquariums, watching high quality science programs on public television, and more.

processes, and devices that go into creating and operating technological artifacts, as well as the artifacts themselves.

* **Engineering** is a body of knowledge about the design and creation of products and processes for solving problems. Engineering utilizes concepts in science and mathematics and as well as technological tools.
* **Mathematics** is the study of patterns and relationships among quantities, numbers, and shapes. Mathematics includes theoretical mathematics and applied mathematics.

Though the STEM acronym is used frequently, especially in education, there is little agreement about what constitutes a comprehensive STEM education. Most often it refers only to formal learning in the disciplines described above. At other times the STEM acronym is used to refer only to science and mathematics content or to teaching and learning in those disciplines.

The SMT Center and many others advocate for a more comprehensive view of STEM and STEM education in two distinct ways. First, in its most complete sense, STEM education should embrace not only formal education in the STEM disciplines, but also engagement in informal and self-directed learning through outdoor experiences, visits to science museums, zoos, aquariums, and access to public television science programs, afterschool programs, and the Internet.

Second, while discreet disciplinary knowledge is important, interdisciplinary knowledge, where academic concepts are coupled with real-world problems and applications, also is important. Interdisciplinary knowledge acquisition requires teaching and learning that departs from traditional science and mathematics education in four distinct ways:

* Technology and engineering design knowledge and skills are integrated throughout the curricula.
* Classes are characterized by students working in teams to solve problems, with teachers facilitating that process and drawing upon a broad range of material and human resources internal and external to the school environment.
* STEM content is integrated across courses and into the problem-solving process.
* Teaching is characterized by "just-in-time" instruction to expedite students' problem-based learning processes.

This comprehensive view of STEM and STEM education is more fully captured by the phrase, "strategies that engage minds." This definition of STEM education is the genesis for the content and organization of this inaugural NC STEM ScoreCard.

The Purpose of the ScoreCard

Our definition of STEM education, Strategies that Engage Minds, provides the rationale for the six domains and associated indicators selected for the NC STEM ScoreCard. This project seeks to establish baseline data to answer three essential questions:

* First, what evidence do we have that North Carolina is engaging and developing PreK-16 students to be motivated and prepared to pursue and acquire the knowledge and skills required in STEM-related occupations and professions?
* Second, what evidence do we have that North Carolina is developing STEM literacy in all citizens so they can understand and make informed decisions about changes in their world?
* Third, what evidence do we have that North Carolina is developing career opportunities for STEM-prepared adults?

STEM Schools in North Carolina

North Carolina is in the process of developing procedures for identifying STEM schools in a standards-based, criteria-based manner. Too often, a school designates itself as a STEM school because STEM disciplines are in the school name, or school leaders equate having science, mathematics and technology in their curriculum as sufficient evidence for the designation. A collaborative effort between the NC STEM Learning Network, the NC Science, Mathematics, and Technology Education Center, and the NC Department of Public instruction has established a set of best practices for what constitutes a STEM school. The process for applying the attributes in a sound and objective manner was field tested in spring 2013 with full implementation possible in 2013-14. The attributes that will be used to define a STEM school in North Carolina are:

1. Project based learning for all students;
2. Opportunities to increase STEM Literacy for all students—particularly female and underrepresented minority students—within formal and informal learning environments;
3. A rigorous curriculum aligned to state, national, international and industry standards, and performance- and project-based assessments;
4. A culture of inquiry, creativity and possibility;
5. Comprehensive information and communication about careers in science, technology, engineering and math fields and other career fields requiring STEM skills, especially girls and minorities;
6. Inspiration and motivation for all students and grow the innate interest all kids have for STEM subjects;
7. Connections and alignment with students' pathways to postsecondary education, through course work, career counseling, and real-world, experience-based learning;
8. Ongoing involvement of business and industry with mentors for each student;
9. Deliberate approach to integrating curriculum across all subject areas, including science, technology, engineering and math;
10. Virtual learning opportunities for all students;
11. Full integration of technology in all classes for all students;
12. Ongoing professional development for each teacher, customized and aligned with integrated content;
13. Externships for teachers in business and industry (annually, if possible);
14. Formal and ongoing community and business engagement;
15. Formal and informal partnerships with other effective programs, initiatives, and research around the world;
16. Encouragement and incentives for innovation among faculty, parents, students and others to increase STEM skills for all students.

Filling the coming boom in STEM-related jobs will be the key to North Carolina's economic growth. It begins now with a new system: *Strategies that Engage Minds*®.

Developing the ScoreCard

The process for developing this ScoreCard entailed attention to its broad purpose while at the same time employing adequate rigor and specificity that could stand up to external scrutiny. Therefore, the Project Team adopted a set of operational standards to guide the developmental process, as follows:

1. **Be guided by evidence, not bias:** To be seen as a reliable source, the ScoreCard content, indicators and recommendations were grounded in metrics and data, even when the evidence was not flattering.
2. **Use defensible data.** To enhance the reliability of the ScoreCard, the Project Team used, where possible, neutral and trusted sources for data rather than extracting data from sources with an overt ideology or point of view.
3. **Report sources.** Transparency is essential and the ScoreCard has sought to document and make known all sources of information and data used in the report.
4. **Report statewide data.** The thrust of this report is on statewide impacts, so many local or regional initiatives were not comprehensively captured.
5. **Think long term.** This ScoreCard is intended to serve as a baseline against which changes over time in North Carolina can be compared.

How We Think About STEM Capacity in North Carolina

We believe that STEM education, at its best, is more fully captured by the central theme of this ScoreCard: *Strategies That Engage Minds*. Our focus is aimed at assessing how North Carolina is developing both STEM literacy and STEM expertise. For North Carolina to develop and sustain STEM-based economic development it must have a literate citizenry as well as programs and opportunities to attract and develop STEM knowledge and skills in our younger citizens.

This ScoreCard serves as a structure to examine our state across the education, business, non-profit, and government sectors, and to assess STEM-related educational and economic progress in North Carolina.

A New System for Thinking About STEM Development

The framework for *Strategies That Engage Minds* starts with an understanding that economic development for a robust North Carolina can best be fueled by cadres of competent and qualified North Carolinians who can help create and do the STEM work of the future. These professional and technical jobs will require different levels of knowledge and skills in STEM disciplines, ranging from certificate programs to advanced graduate-level degrees. However, it's important to think about "STEM for all" which suggests that everyone should have a general understanding and appreciation of STEM, if for no other reason than to be able to understand our world and act as responsible citizens. The formal and informal education of children, students and adults works in different ways to achieve STEM literacy and STEM careers.

STEM knowledge and literacy are developed through a trilogy of interlocking principles: Engagement, Development, and Persistence. This trilogy makes up the structure and domains of the STEM ScoreCard.[29] In order to become engaged in STEM learning, to develop the knowledge and skills associated with STEM job success, and to persist in STEM occupations and to increase STEM knowledge and skills throughout one's career, strategic investments must be provided from both public and non-public sources in North Carolina.

Engagement

STEM interest and learning begins very early as we all come into the world naturally curious. This fundamental disposition drives STEM learning,

[29] Adapted from the work of Jolly E., Campbell P., and Perlman, L. (2010) *Engagement, Capacity, and Continuity: A Trilogy for Student Success.* (www.campbell-kibler.com).

The STEM Pipeline

Preparing the highly skilled workforce that North Carolina will need to prosper in today's fast-changing economy with Strategies That Engage Minds®

GUIDING PRINCIPLES

ENGAGEMENT DEVELOPMENT PERSISTENCE

PREPARE

FORMAL EDUCATION: PreK-12 | Certifications | Undergraduate/Graduate Studies | Professional Degrees

INFORMAL EDUCATION: Museums | Learning Centers | Competitions | Enrichment Programs

PROSPER

Economic development for a robust North Carolina can best be fueled by cadres of competent and qualified North Carolinians.

The coming boom in STEM-related jobs holds the key to North Carolina's future economic prosperity.

EVALUATE

The STEM ScoreCard provides a comprehensive assessment of where North Carolina stands across six domains that are vital in plotting the course for our future economy.

- STEM WORKFORCE AND ECONOMIC IMPACT
- INFORMAL EDUCATION AND STEM LITERACY
- STRATEGIC INVESTMENTS AND INNOVATION
- COLLEGE AND CAREER READINESS
- TEACHER QUALITY
- LEADERSHIP AND POLICY SUPPORT

STEM knowledge and literacy are developed through a trilogy of interlocking principles: Engagement, Development, and Persistence.

one that is greatly enhanced by visits to nature centers, science and technology museums, planetariums, aquariums, zoos, state parks and through the development of hobbies, building rockets, for example. Engagement may also come from watching STEM programs on public access television, like *Curious George*, *Nature* and *Nova*, and through reading magazines and books, listening to radio, and through access to the enormous array of resources available on the Internet. These informal free-choice venues are as important to adults as they are for children.

Development

Development of STEM knowledge, skills and dispositions for young people largely occurs in PreK-12 schools and postsecondary studies, primarily in the state's public schools, community colleges, the University of North Carolina system, and in the independent colleges and universities across the state. All parts of this education network must function well to provide for students a well-designed and sequenced curriculum and assessments aligned to high standards, with high-quality teachers and professors teaching to those standards, guided by effective leaders, and with aligned assessments to determine outcomes. High school graduation requirements must be aligned with college and university entry requirements. Postsecondary institutions must offer an array of technical and academic programs to develop qualified and competent North Carolinians able to compete for and secure the STEM jobs of the future.

Persistence

Persistence and continuity matter throughout the STEM pipeline of development so that young learners, who become interested and engaged in STEM subjects and disciplines, can continue to develop their interest. The role of clubs, student competitions in science, mathematics, and technology, and schools focused on math and science are some of the keys to nurturing student knowledge and interest and translating that knowledge and ability into preparation for STEM-related careers. Persistence in STEM careers in North Carolina will depend on policies that capitalize on public and private investments in the formal and informal STEM education of students and adults. STEM knowledge changes so rapidly, so continuous learning is critical to economic development. The aphorism about preparing people for jobs not yet invented is our current reality.

To become engaged in STEM learning, to develop the knowledge and skills associated with STEM job success, and to persist in keeping and developing STEM and job-related knowledge and skills throughout one's career, strategic investments must be provided from both public and non-public sources. The state already has established exemplary programs and policies—highlighted later in this report—which can serve as a roadmap to developing new high-quality programs to serve more North Carolinians.

Domains

The North Carolina STEM Scorecard is organized around six domains that represent an overall assessment of how deeply the central theme, *Strategies That Engage Minds*, is embedded in the state's work.

The ScoreCard begins with the end in mind by providing an assessment of a probable **STEM Workforce and Economic Impact** scenario for North Carolina between now and 2018-2020,

when STEM knowledge and skills will likely play an even more vital role in the state's economic growth. We pay particular attention to future job opportunities in the medical and allied health professions. This assessment also examines how well North Carolina compares to its neighboring states in the South.

The second domain of the ScoreCard examines the factors of **Informal Education and STEM Literacy***, both for young people and for adults, through participation in informal education, afterschool programs, and self-directed learning outside of schools. A multitude of opportunities exist, and they are now known to be integral to the development of STEM literacy, engagement, and career development.

The third domain is **Strategic Investments and Innovation**, in which the ScoreCard identifies a range of essential supports for cultivating a STEM-literate citizenry in North Carolina, developing special talents and capacity of teachers and students, and creating an infrastructure of support for STEM education. Most of the programs identified are supported by public and private dollars that are leveraged to create the maximum value for individuals and for North Carolina.

The fourth domain examines **College and Career Readiness** to determine how well North Carolina's students and schools navigate the STEM education pipeline on the pathway to STEM occupations. This requires not just academic achievement in STEM-related subjects, but also broad participation and success in the challenging Advanced Placement STEM curricula that tend to predict postsecondary success in STEM-related occupations.

The fifth domain assesses **Teacher Quality**, specifically the extent to which the state prepares, develops, and supports beginning STEM educators to better ensure high-quality teaching and retention of effective STEM teachers.

Included in this assessment is an examination of the depth of content knowledge of STEM teachers, the effectiveness of beginning teachers and retention in STEM teaching from different pathways into teaching.

Finally, in the sixth domain, the ScoreCard examines **Leadership and Policy Support** by determining the degree to which local school districts indicate their understanding of the importance of STEM learning, and how well their programs support such an understanding.

Throughout, the STEM ScoreCard showcases exemplars of current programs and initiatives in North Carolina that demonstrate the three core principles—Engagement, Development and Persistence.

Indicators and Metrics

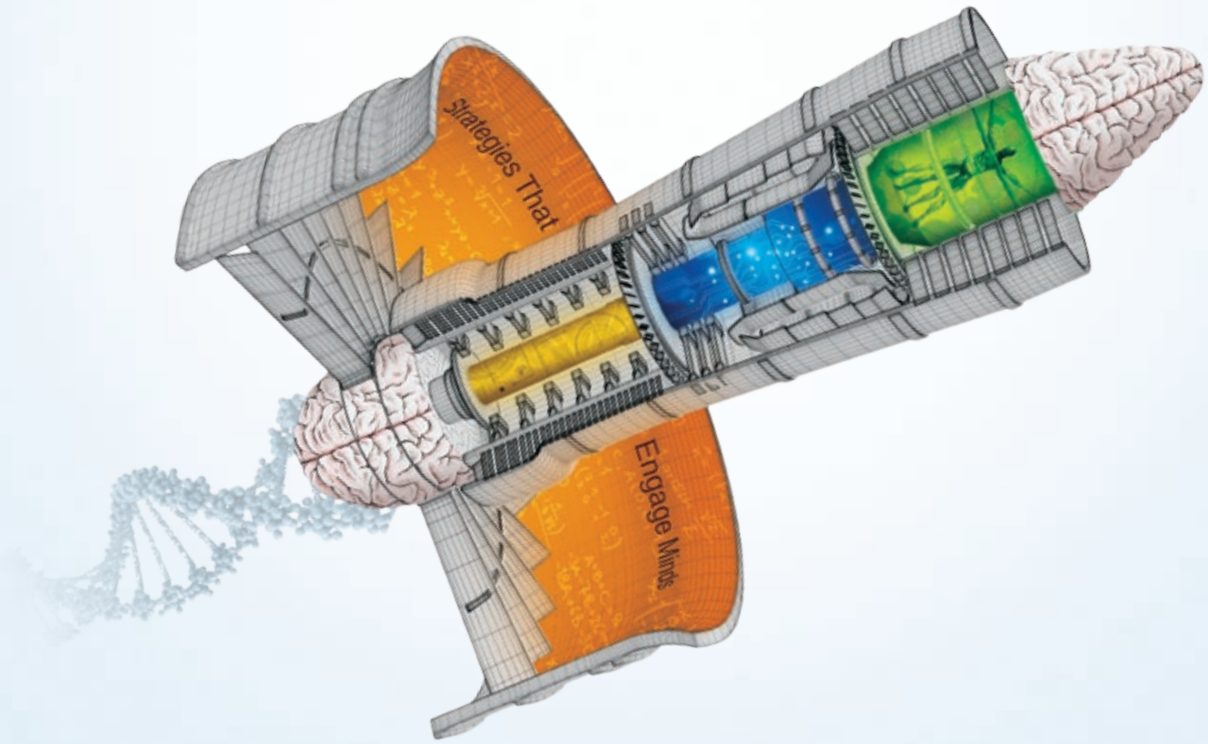
Within each domain we identified a series of indicators that could provide critical insights into the state's capacity to prepare STEM-savvy citizens for the jobs of the future. Each indicator measured a piece of the overall picture of STEM capacity. We employed a metric that met our operational standards and also contributed to understanding the framework of each domain. Most often, the metric we used was reported as a percentage (i.e., percentage of 4th graders proficient on the NAEP mathematics exam). If a percentage was not available or was inappropriate, we used raw numbers of participants (i.e., number of teachers receiving professional development). We consulted with many STEM authorities in North Carolina to review and make additions and deletions to the proposed indicators. Any indicator that could not be matched by a metric that met our operational standards was set aside for future use when it can better inform the work of the ScoreCard.

This STEM ScoreCard is organized around six domains that represent an overall assessment of how deeply the central theme, *Strategies That Engage Minds*, is embedded in the state's work.

* Note: STEM Literacy is the knowledge and understanding of STEM disciplinary concepts and processes required to support personal decision making, problem solving, participation in civic and cultural affairs, creativity and innovation and economic productivity. It includes the ability to use knowledge and processes across the disciplines of mathematics, physics, chemistry, biological sciences, earth/space sciences, engineering and technology in order to understand, participate and contribute effectively in decisions that affect life and health, earth and environment, design, technology, and the economy.

DOMAIN ONE:

STEM Workforce and Economic Impact



The goal: Promote collaboration across public and private sectors to create a strong STEM workforce and economic development for North Carolina.

The STEM ScoreCard begins with an assessment of how well prepared North Carolina is to meet the economic realities of this second decade of the 21st century. This domain documents how successful North Carolina is in developing its STEM workforce capacity relative to the rest of the United States and to its neighbors in the South. This first section discusses current and projected job growth and opportunities in STEM-related occupations.

Two key questions framing this domain are: (1) What are the most probable realities for STEM jobs for the remainder of this decade given the overall economic climate of North Carolina? and, **(2) Are we producing a sufficient supply of qualified and competent people to join the workforce and lead in the development of a new, more robust economy for North Carolina?** While projections are subject to any number of unseen and unanticipated forces, current data sources can help us to anticipate probable futures with reasonable confidence.

Job Growth and Opportunities (2018-2020)

According to projections by the Georgetown University Center on Education and the Workforce[30], North Carolina, by 2018, will grow about 332,000 new jobs that will require post-secondary education and/or training, while it will only grow about 157,000 new jobs for which a high school education or a dropout would be suited. Of the 1.4 million job vacancies anticipated over this decade, about 833,000 will require postsecondary education of some kind. By 2018, it is further anticipated that 59 percent of all jobs in North Carolina will require postsecondary education.

332,000

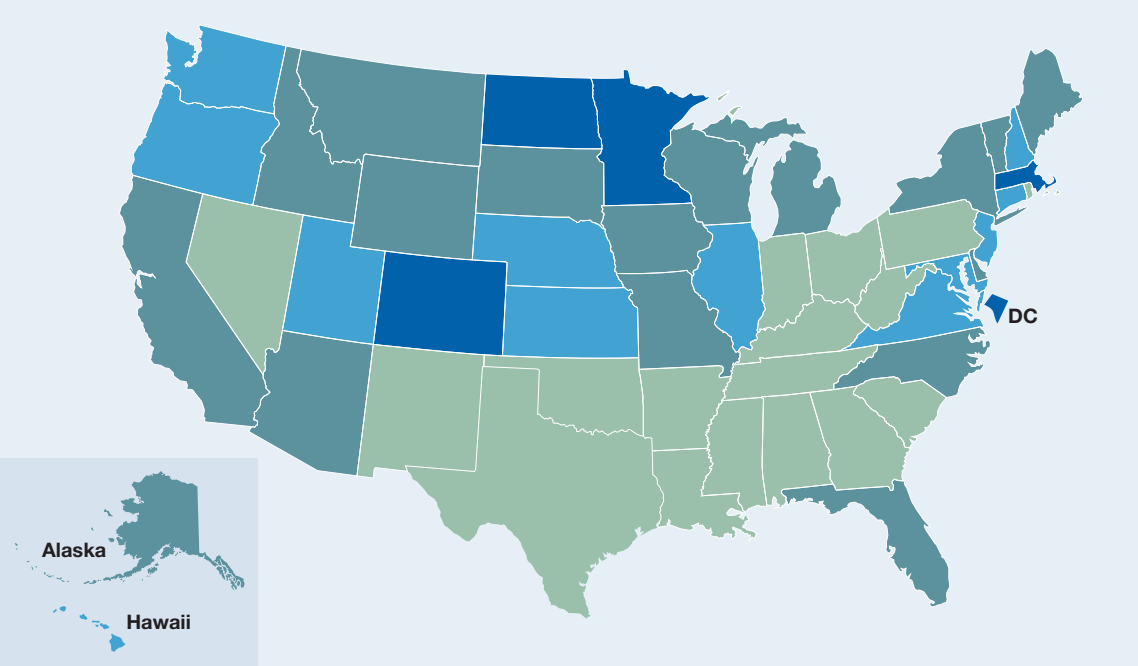
By 2018, North Carolina will grow about 332,000 new jobs that will require postsecondary education, according to projections by the Georgetown University Center on Education and the Workforce.

[30] Carnevale, A.P., Smith, N. & Strohl, J. (2010). Helped wanted: Projections of jobs and educational requirements through 2018. Georgetown University Center on Education and the Workforce. www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/State-LevelAnalysis-web.pdf.

59%

It is anticipated that 59 percent of all jobs in North Carolina will require postsecondary education by 2018.

Share of Total Jobs Within States Requiring Postsecondary Education in 2018



Source: Center on Education and the Workforce forecast of educational demand through 2018.

The Georgetown University Center report also indicates that approximately one third of jobs will require at least a bachelor's degree and slightly fewer will require an associate's degree or higher. Almost a quarter of those jobs will require some graduate-level education (see table at right).

Of those same jobs, over a quarter million will be STEM related, including a projected need of approximately 110,000 jobs in computer and mathematical sciences, 17,000 architects and technicians, 50,000 engineers and technicians, and 36,000 life and physical scientists—a figure that does not include the myriad of job opportunities in the medical professions and other allied health occupations.[31] More to the point, about 91 percent of all STEM jobs will require post-secondary education and/or training by 2018.

Educational Distribution of STEM Jobs in NC, Projected 2018

High school or less	18,970	9%
Some college	31,040	15%
Associate's degrees	26,120	12%
Bachelor's degrees	91,350	43%
Master's degrees	37,480	18%
Doctoral degrees	7,860	4%
Total	**212,820**	**100%**

Source: Center on Education and the Workforce (Georgetown University) State Level Analysis – 2010

[31] Carnevale, A. Smith, N. & Melton, M. (2011). STEM: Science, technology, engineering, mathematics. Georgetown University Center on Education and the Workforce. http://cew.georgetown.edu/STEM.

[32] National Science Board, Science and Engineering Indicators 2012, www.nsf.gov/statistics/seind12/c8/c8i.htm.

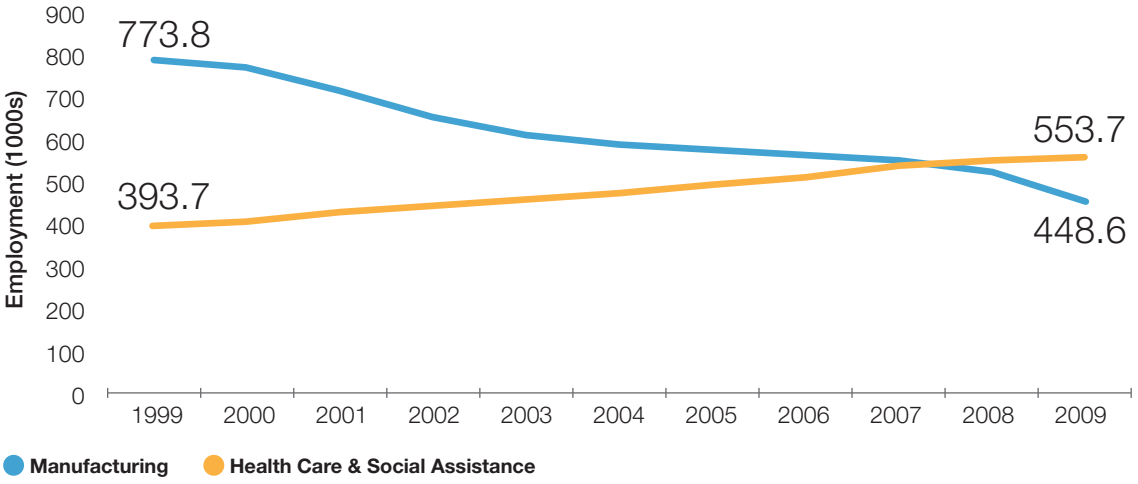
What is a STEM job? The National Science Foundation[32] has classified the fields that it considers as high technology industries. Those include:

- Aerospace manufacturing
- Agri-chemicals
- Architect/engineer
- A/V equipment manufacturing
- Chemical manufacturing
- Commercial equipment/supplies
- Commercial machines
- Communications manufacturing
- Computer manufacturing
- Computer systems design
- Data hosting and processing
- Electric power
- Electrical equipment
- Energy manufacturing
- Forestry
- Industrial machines
- Instrument manufacturing
- Internet publishing
- ISP and web portals
- Machine manufacturing
- Magnetic/optics media
- Monetary and banking
- Oil/gas extraction
- Oil/gas pipeline transport
- Paints and adhesives
- Petroleum/coal products
- Pharmaceuticals
- Satellite communications
- Science/tech consulting
- Scientific R & D
- Securities exchanges
- Semiconductor manufacturing
- Software publishing
- Synthetic materials
- Telecommunications
- Transportation equipment

This list illustrates the relationship between the need for STEM knowledge and skills as well as access *and* continuing success in these fields.

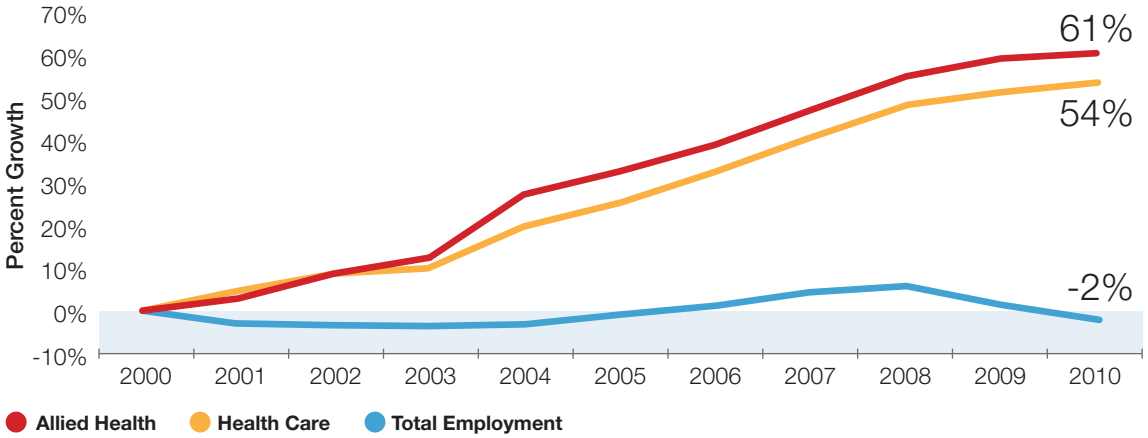
91% of all STEM jobs will require post-secondary education and/or training by 2018.

Total Employment in Manufacturing and Health Care and Social Assistance Employment in North Carolina 1999-2009



According to the North Carolina Institute of Medicine, the state needs three doctors and 10 nurses to start their practices every day just to maintain present needs.

Percent Growth in North Carolina Employment Relative to 2000



Source: North Carolina Health Professions Data System with data derived from the U.S. Bureau of Labor Statistics, Occupational Employment Statistics, State Cross-Industry Estimates: 2000-2010. URL: www.bls.gov/oes/oes_dl.htm. Accessed 9/13/11, revised 3/21/12.

Job Growth and Opportunities in Medical and Allied Health Occupations (2018-2020)

Growth in the medical professions and allied health services is anticipated for North Carolina in the coming decade, particularly for those occupations designated as "primary care" occupations. In fact, growth in this sector of the economy is expected to increase while job growth in manufacturing, as a portion of the overall economy, is declining. In the first decade of the 21st century in North Carolina, allied health and health care employment grew significantly while total employment declined, a consequence of the 2007-09 recession.

According to the North Carolina Institute of Medicine, two new doctors, eight new nurses, and two other licensed health practitioners start their practices in the state every day. However, North Carolina needs three doctors and 10 nurses to start their practices every day just to maintain present needs.[33] Keeping up is falling behind. With an increasingly aging population, the demand for medical services under the Affordable Care Act, plus retirements in the health care industry, the need for medical practitioners will only increase. As that need increases so, too, does the need for jobs that support primary care practitioners—therapists, pharmacists, mental health professionals, and other support practitioners. Data from 2011 show 7.8 primary care physicians per each 10,000 in population in North Carolina, which is below the national average. Currently the state has, approximately, over 95,000 registered nurses, another 18,000 licensed practical nurses, nearly 4,000 nurse practitioners, about 3,900 physician assistants and slightly over 4,200 dentists.[34]

Not only does North Carolina's ratio of primary care physicians to the general population lag behind the national percentage, so does its ratio of medical students per 100,000 in the general population. Compared to several neighboring

[33] NC Institute of Medicine (2012). Examining the impact of the Patient Protection and Affordable Care Act in North Carolina: Draft final report pending U.S. Supreme Court Decision (2012). North Carolina institute of Medicine. www.nciom.org/wp-content/uploads/2012/05/Full-Report-Online-Pending.pdf.

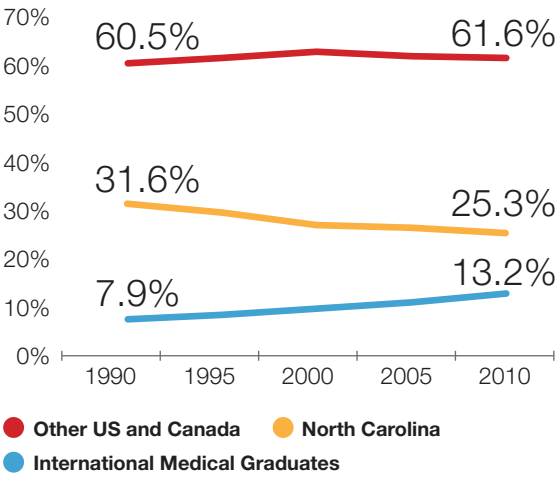
[34] Cecil G. Sheps Center for Health Services Research – UNC Chapel Hill (2011). North Carolina health professions 2011 data book, www.shepscenter.unc.edu/hp/publications/2011_HPDS_DataBook.pdf.

Geographic Jurisdiction	Number Medical Students per 100,000 in General Population
Georgia	18.3/100,000
South Carolina	21.2/100,000
Tennessee	27.8/100,000
Virginia	22.6/100,000
United States	23.5/100,000
North Carolina	**19.8/100,000**

states and the U.S. as a whole, North Carolina's lower ratio will make it difficult to catch up and provide adequate services statewide, although the opening of a new medical school in 2013 at Campbell University will help in some measure.

This supply/demand problem is further exacerbated by the migration patterns of physicians prepared in North Carolina's medical schools. Only one-quarter of the state's practicing physicians graduated from a North Carolina institution, and that percentage has been decreasing. More than 61 percent of our MDs come from medical schools in other states and/or Canada. That percentage has been fairly steady over time. Slightly over 13 percent are graduates from international medical schools. North Carolina is a net *importer* of primary care physicians, indeed all physicians. These figures illustrate that North Carolina doesn't produce enough physicians, and those it does produce tend to take their knowledge and talent elsewhere.

Active Licensed NC Physicians by Medical School Location, 1990-2010



Another disturbing statistic is that only about one fifth (21 percent) of graduates from NC's medical schools practice in the primary care fields, although most physicians from international schools tend to gravitate to primary care practices.[35]

The data regarding available dental care is equally worrisome. North Carolina lags well behind the rest of the country in the ratio of dentists per 10,000 in the general population. The national average is six dentists per 10,000; the North Carolina ratio is 4.4 per 10,000. Part of this problem has been the lack of access to dental education in the state. Until 2011 when East Carolina opened a new dental school, the only dental school was at UNC-CH.

In addition to the lack of access to dental education programs, the geographic distribution of new dental school graduates limits access to dental care across the state. New dentists do not set up practices in rural areas. In fact, only about 9 percent of in-state graduates, and 14 percent of out-of-state graduates, practice in rural areas.

Statewide, this distribution picture is even more dramatic. The color coding in the figure on the following page shows that three NC counties have no active dentists, and in 24 other counties

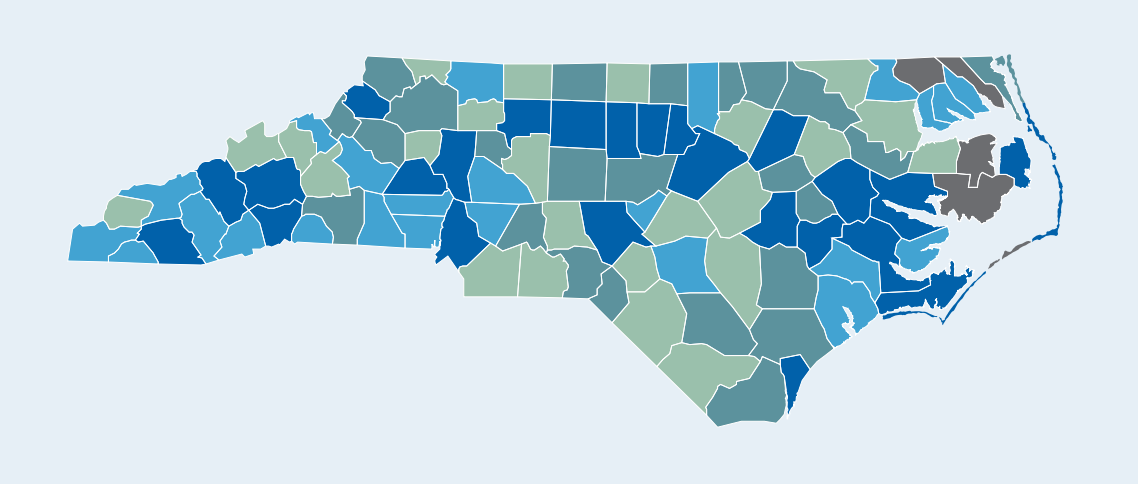
61%

Slightly more than 61 percent of MDs in North Carolina come from medical schools in other states and/or Canada.

[35] Fraher, E., Newton, H., & Lyons, J. (2012). Trends in medical education in North Carolina. www.shepscenter.unc.edu/hp.

North Carolina lags well behind the rest of the country in the ratio of dentists per 10,000 in the general population. The national average is six dentists per 10,000; the North Carolina ratio is 4.4 per 10,000.

Dentists per 10,000 Population, North Carolina 2009



Dentists per 10,000 Population (Number of Dentists)

4.00 to 10.36 (24) **2.81 to 3.99 (24)** **2.09 to 2.80 (24)** **0.01 to 2.08 (24)** **No Active Dentists (4)**

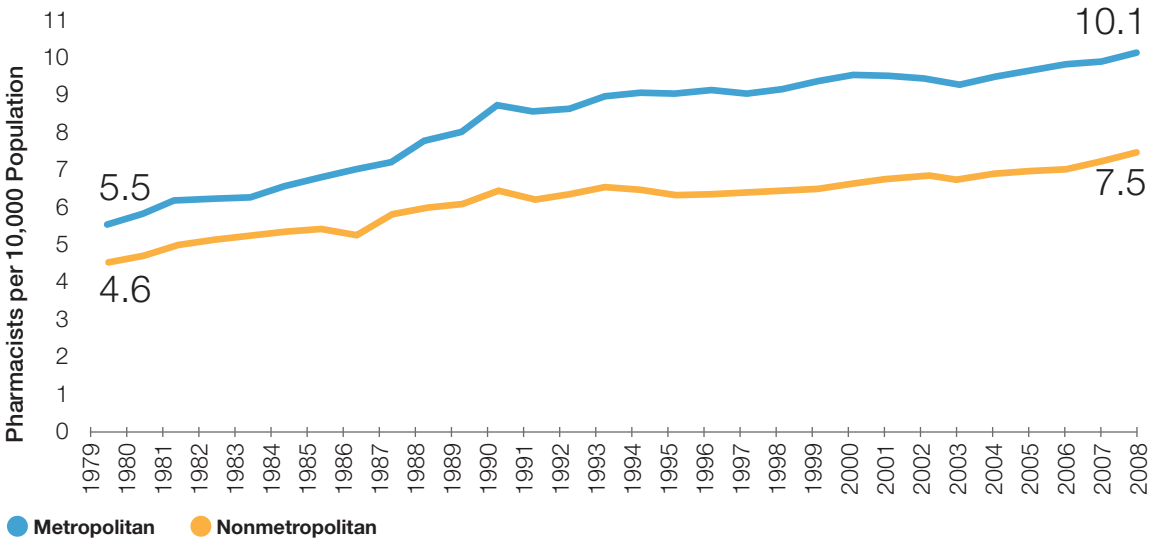
*Dentists included are active or have unknown activity status.
Source: North Carolina Health Professions Data System, with data derived from the NC State Board of Dental Examiners, 2009.
Produced by: North Carolina Health Professions Data System, Cecil G. Sheps Center for Health Services Research, University of North Carolina at Chapel Hill

the ratio is equal to or less than 2.08 dentists per 10,000 in the general population. Moreover, the Sheps Center projects a ratio of 4.23 dentists per 10,000 by 2020, even with the additional dentists soon to be graduating from the new dental school at East Carolina University.[36] As in medicine, it will be difficult for North Carolina to catch up to its need for dentists.

Pharmacology presents a somewhat different picture. The ratio of pharmacists to the general population in North Carolina is above the national average and it continues to increase, even as other states' ratios are declining. The ratio in North Carolina is 9.3 pharmacists per 10,000 in the general population, compared to 8.0 nationally. The distribution index shows 7.5 pharmacists per 10,000 in non-metro areas, only slightly below the national average for all pharmacists. Three North Carolina institutions have approved programs in pharmacology: Campbell University, UNC-Chapel Hill (with a partnership program with Elizabeth City State University), and Wingate University.

[36] McGee, V., Odle, T., Lyons, J., Gaul, K. & Fraher, E. (2011). Trends in the Supply, distribution and employment of dentists in North Carolina. www.shepscenter.unc.edu/hp.

North Carolina Pharmacists per 10,000 Population by Metropolitan and Non-metropolitan Counties 1979-2008



Sources: North Carolina Health Professions Data System, 1979 to 2008; North Carolina Office of State Planning; Office of Management and Budget. Figures include all licensed, active, instate pharmacists. North Carolina population data are smoothed figures based on 1980, 1990 and 2000 Censuses.

The ratio of pharmacists to the general population in North Carolina is above the national average and it continues to increase, even as other states' ratios are declining. The ratio in North Carolina is 9.3 pharmacists per 10,000 in the general population, compared to 8.0 nationally.

The anticipated need for health care jobs will also drive the need for technical support systems to manage health services. These services include data collection and analysis, claim management, reimbursement distribution, and call centers, to name just a few. According to a report by the Kaiser Family Foundation, tech-savvy firms are increasing their contracts with governmental agencies responsible for overseeing medical programs such as Medicare and the health insurance exchanges operating in many states.[37]

ScoreCard Analysis

The ScoreCard Project Team used 18 indicators to measure North Carolina's readiness and capacity to expand and strengthen STEM education and STEM job opportunities. The data presented below, from the National Science Board, *Science and Engineering Indicators 2012* unless otherwise noted, indicate how North Carolina's efforts compare to other Southern[38] states as well to the rest of the country.

[37] Galewitz, P. (2012). Health care law may boost tech firms. Kaiser Health News. www.kaiserhealthnews.org/Stories/2012/December/21/xerox-hp-help-states-run-medicaid.aspx.

[38] For purposes of the analyses in this ScoreCard, the South is defined as consisting of the following states: Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas, and Virginia.

86.8% of North Carolinians between the ages of 25 and 44 are high school graduates.

Academic Attainment

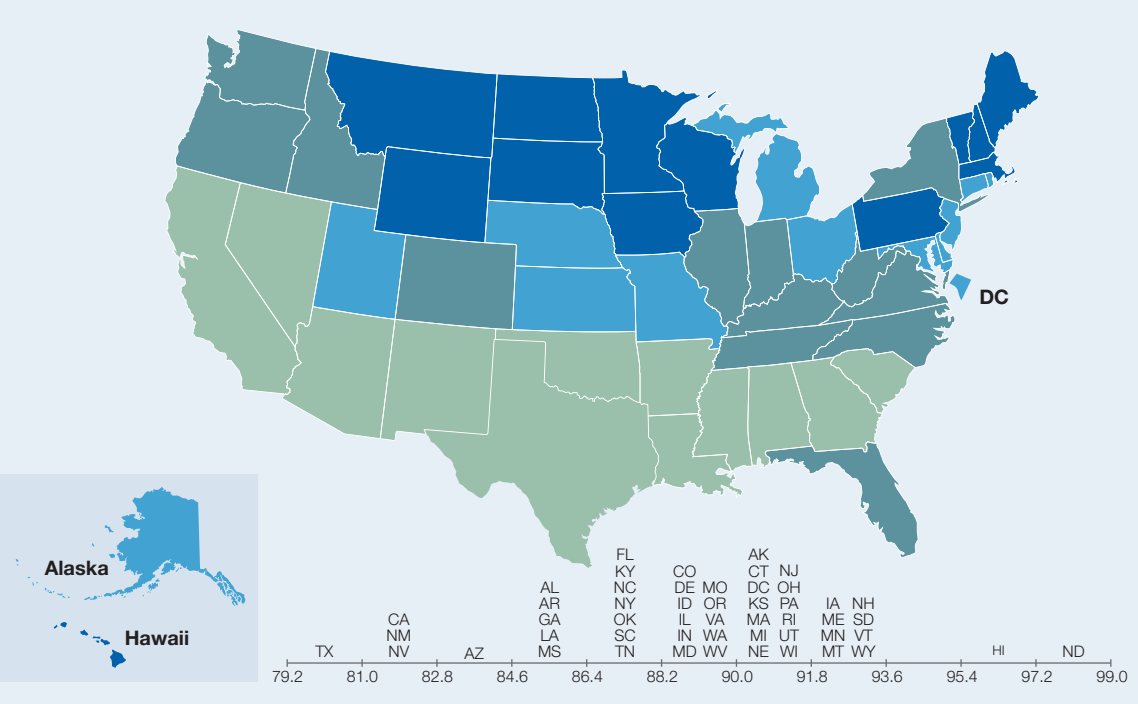
Indicator 1: Percent of high school graduates among individuals 25–44 years old

Metric (2011-12): NC: 86.8% *(3rd Quartile in the U.S.; NC ranked 4th in the South after VA, TN, and FL);* **US: 87.1%**[39]

This indicator represents the percentage of the early- to mid-career population that has earned at least a high school credential. The map below shows where high school graduates live rather than where they were educated. High values indicate a resident population and potential workforce with widespread basic education credentials. Estimates of educational attainment have been developed by the U.S. Census Bureau.

The next two indicators communicate similar data for North Carolina's young population already holding some measure of postsecondary degree attainment.

High School Graduates Among Individuals 25-44 Years Old: 2009



1st quartile (91.5%-98.3%) **2nd quartile (89.4%-91.3%)** **3rd quartile (86.8%-89.3%)** **4th quartile (80.8%-86.6%)**

Source: Census Bureau, 2000 Decinnial Census, Population Estimates Program, and American Community Survey.

[39] Estimates of population ages 25–44 are provided by the Census Bureau based on the 2000 Decennial Census. Estimates for states with smaller populations are generally less precise than estimates for states with larger populations. (www.nsf.gov/statistics/seind12/c8/interactive/map.cfm?table=15) Data from 2005 and later are derived from the American Community Survey (ACS), the largest household survey in the United States, with a sample size of about 3 million addresses. The ACS collects information on an annual basis. Data prior to 2005 were derived from the Decennial Census.

Indicator 2: Percent of young adults (ages 25-34) with at least a two-year degree, including the U.S. and Southern states[40]

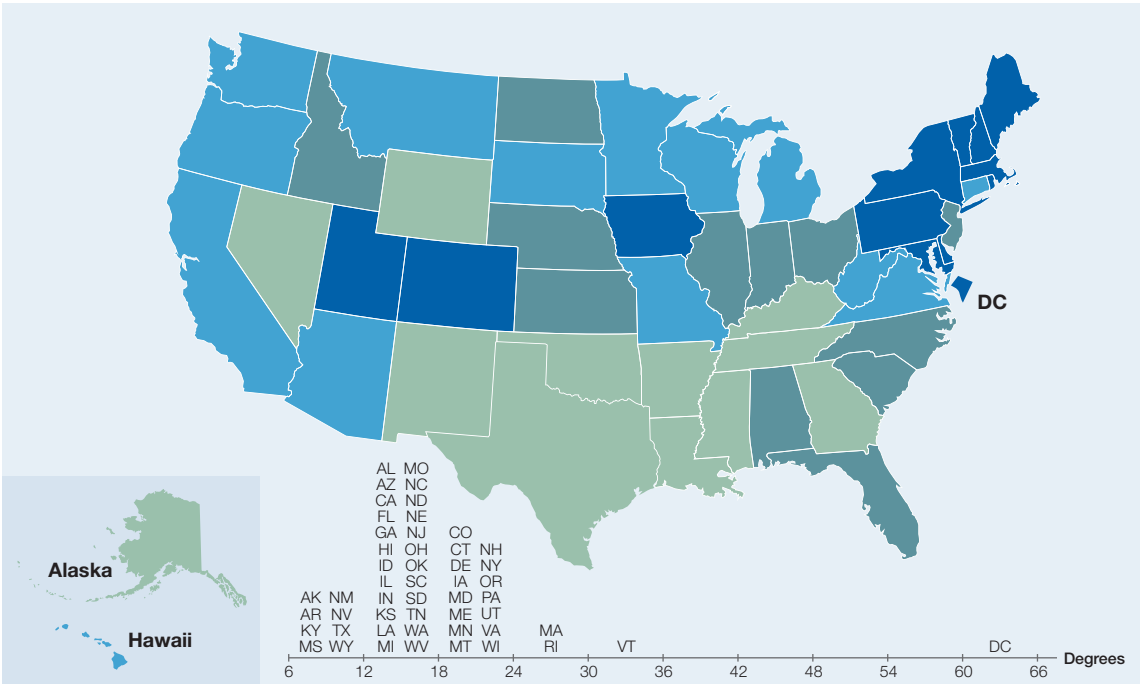
Metric (2011-12): NC: 35% *(NC ranked 2nd in the South, after VA, which was the only Southern state to exceed the US average);* **US: 39%** *(US ranked 11th out of OECD countries,*[41] *well behind Canada, Japan, South Korea and Israel)*

The Lumina Foundation, in its report, *A Stronger Nation*, called on the United States to achieve a "big goal" of 60 percent of the adult population with postsecondary degrees or certificates by 2025. While North Carolina has had some success in increasing completion rates over the past decade, the current rate of growth, according to Lumina, would yield only a 47.5 percent college-degree attainment rate among working-age adults in North Carolina by 2025. To reach the 60 percent goal, the state would have to increase by 7 percent each year the number of its college students who receive associates or bachelor's degrees—that is, 9,440 more graduates annually between now and 2025.

To reach that level of degree completion, North Carolina must address the persistent achievement gaps for first-generation students, low-income adults and adolescents and students of racial and ethnic minorities. Along with the nation as a whole, North Carolina has wide gaps in attainment

35% of North Carolinians between the ages of 25 and 34 hold at least a two-year degree.

Bachelor's Degrees in Science and Engineering Conferred per 1,000 Individuals 18-24 years old: 2009



1st quartile (20.2-62.2) **2nd quartile (16.6-20.0)** **3rd quartile (13.6-15.9)** **4th quartile (7.0-13.2)**

Source: National Center for Education Statistics, Integrated Postsecondary Education Data Systems; Census Bureau, 2000 Decennial Census and Population Estimates Program.

[40] The Program in Public Life, University of North Carolina at Chapel Hill. http://southnow.org/files/2011/10/cc11.pdf.
[41] Organization for Economic Cooperation and Development – www.oced.org.

5.7%

The percentage of bachelor's degrees in science and engineering conferred per 1,000 individuals in North Carolina is 5.7%. The national average is 16.5%.

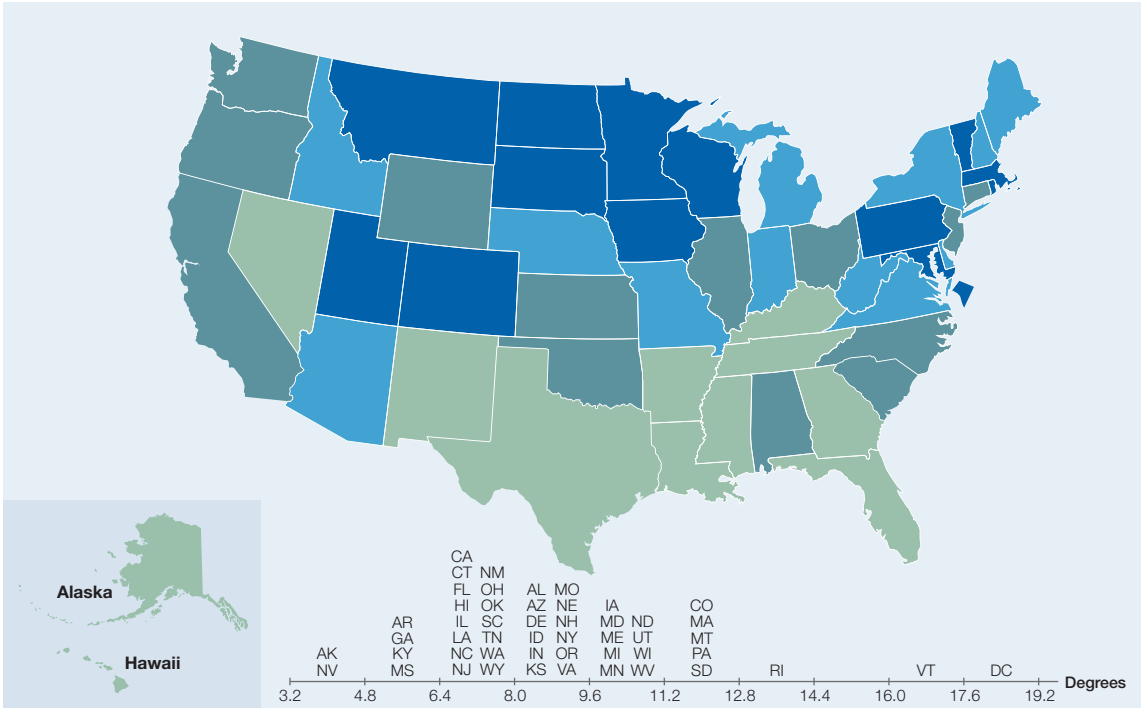
levels among whites, blacks, Hispanics, Asians and Native Americans. As the largely white Baby Boom generation moves into retirement over the next 10-15 years, the state's economy will become increasingly dependent on younger cohorts of ethnically diverse residents.

Indicator 3: Percent of bachelor's degrees in science and engineering conferred per 1,000 individuals, 18-24 years old

Metric (2011-12): NC: 5.7% *(NC ranked 2nd in the South, after VA, the only Southern state to exceed the US average);* **US: 16.5%**[42]

Educational attainment in a science and engineering (S&E) field gives people greater opportunities to work in higher paying technical jobs than are generally available to those in other fields of study. Earning a bachelor's degree in an S&E fields also prepares an individual for advanced technical education. The 18–24-year-old cohort was chosen to approximate the age range of most students who are pursuing an undergraduate degree. This indicator represents the extent to which a state provides bachelor's level training in S&E fields.

Bachelor's Degrees in Natural Sciences and Engineering Conferred per 1,000 Individuals 18-24 Years Old: 2009



Source: National Center for Education Statistics, Integrated Postsecondary Education Data Systems; Census Bureau, 2000 Decennial Census and Population Estimates Program.

[42] National Science Board Science and Engineering Indicators (2012): State Indicators.

A high value for this indicator suggests the successful provision of undergraduate training in S&E fields. The number of bachelor's degrees awarded in S&E fields is based on an actual count provided by the National Center of Education Statistics. Estimates of the population, ages 18–24 years are provided by the U.S. Census Bureau.

On both the second and third indicators, North Carolina ranks second in the South, behind Virginia, so we do as well or better than our Southern counterparts. However, the state lags behind much of the upper Midwest and almost the entire Northeast (see map at left).

Access and Opportunity

The next set of indicators is aligned to STEM workforce conditions and circumstances in North Carolina. They describe current access and opportunity to meet readiness for the anticipated challenges for North Carolina.

Indicator 4: Average undergraduate cost at public four-year institutions

Metric (2009-10): NC: $11,847 average *(10th lowest in the U.S.; NC has the 5th lowest tuition in the South, after LA, MS, FL and AR);*
US: $15,014 average *(Ranging from a low of $10,109 to a high of $21,591).*[43]

The average annual cost for an undergraduate student to attend a public four-year academic institution is one indicator of how accessible higher education is to students. The annual cost typically includes tuition, required fees, room, and board for a full-time resident undergraduate student. These costs were weighted by the number of full-time undergraduates attending each public institution within the state. (The data presented in this indicator do not include any adjustments for financial aid.) To arrive at the average, the total cost for all state public four-year institutions was divided by the total number of full-time undergraduates enrolled in all state public four-year institutions. The year indicated represents the end date of the academic year, for example, data for 2010 represent costs for the 2009–10 academic year.

All states showed major increases in undergraduate costs at public institutions in 2010 since 2000. In several states, including North Carolina, undergraduate costs more than doubled during this period. During 2010, the total annual cost for a full-time undergraduate student to attend a public four-year institution averaged $15,014 nationally, an increase of 82 percent since 2000 in current dollars. During this same period, North Carolina experienced a 73 percent increase, rising from $6,843 in 2000 to $11,847 in 2010.

To improve educational attainment, the federal government, state governments, and academic institutions provide various kinds of financial aid that reduce the cost to students. In recent years, North Carolina has ranked second in the nation in growth of fiscal support for higher education. According to the College Board, North Carolina's per capita fiscal support grew by 17.5 percent.

$11,847 is the average yearly charge for undergraduates at North Carolina's public four-year institutions is $11,847—the 10th lowest in the US. The national average is $15,014.

[43] National Science Board Science and Engineering Indicators (2012): State Indicators and Carolina Context, Program on Public Life, The University of North Carolina at Chapel Hill. January 2011, Number 11.

3.84%

The percentage of North Carolinians employed in science and engineering occupations is 3.84% which ranks it 2nd in the South after Virginia. The national average is 4.0%.

The STEM Workforce

Indicator 5: Bachelor's degree holders potentially in the workforce

Metric (2011-12): NC: 34.7% *(2nd Quartile in the U.S.; Ranked 3rd in South, after VA, GA);* **US: 34.6%**[44]

This indicator (see table at right) represents the percentage of the early- to mid-career population that has earned at least a four-year undergraduate degree. The data are based on where college degree holders live rather than where they were educated. The age 25–44 cohort represents a group of individuals who are potential long-term participants in a state's workforce.

Estimates of educational attainment are developed by the U.S. Census Bureau. Small differences in the value of this indicator between states and across time generally are not meaningful.

Indicator 6: Individuals in science and engineering occupations as a percent of the workforce

Metric (2011-12): NC: 3.84% *(Ranked 2nd in South, after VA);* **US: 4.00%**[45]

This indicator (see table at right) represents the extent to which a state's workforce is employed in S&E occupations. A high value indicates that a state's economy has a high percentage of technical jobs relative to other states. S&E occupations are defined by standard occupational codes. They include engineering and computing, mathematics, and life, physical, and social sciences. Managers, technicians, elementary and secondary school teachers, and medical personnel are not included.

Indicator 7: Employed science and engineering doctorate holders as a percent of the workforce

Metric (2011-12): NC: 0.47% *(Ranked 2nd in the South, after VA);* **US: 0.45%**[46]

This indicator (see table at right) represents a state's ability to attract and retain highly trained scientists and engineers. These individuals often conduct research and development (R&D), manage R&D activities, or are otherwise engaged in knowledge-intensive activities. A high value for this indicator in a state suggests employment opportunities for individuals with highly advanced training in S&E fields.

Data on employed S&E doctorate holders include those with doctoral degrees in computer and mathematical sciences; biological, agricultural, or environmental life sciences; physical sciences; social sciences; psychology; engineering; and health fields. S&E doctorate data exclude individuals with doctorates from foreign institutions and those above the age of 75. S&E doctorate holders are assigned to a state based on where they work.

Indicator 8: Engineers as a percent of the workforce

Metric (2011-12): NC: 0.81% *(Ranked 7th in the South, after AL, GA, TN, SC, TX, and VA);* **US: 1.12%**[47]

Engineers design and operate production processes and create new products and services. This indicator (see table at right) represents the percentage of trained engineers in a state's workforce. It includes the standard occupational codes for engineering fields: aerospace, agricultural, biomedical, chemical, civil, computer hardware, electrical and electronics, environmental, industrial, marine and naval architectural, materials, mechanical, mining and geological, nuclear, and petroleum.

[44] www.nsf.gov/statistics/seind12/c8/interactive/map.cfm?table=31.
[45] National Science Board. 2012. Science and Engineering Indicators 2012. Arlington VA: National Science Foundation (NSB 12-01).
[46,47] National Science Board Science and Engineering Indicators (2012): State Indicators.

Summary of the STEM Workforce in North Carolina

(Percentage of total workforce)

Indicator	N.C.	U.S.	N.C. Rankings
Bachelor's degrees	**34.7%**	34.6%	3rd in the South (behind VA and GA), 2nd quartile nationally
Science and Engineering	**3.84%**	4.00%	2nd in the South (behind VA)
Employed holders of doctorates in Science and Engineering	**.047%**	.045%	2nd in the South (behind VA)
Engineers	**.081%**	1.12%	7th in the South (behind AL, GA, TN, SC, TX, and VA)
Life and Physical Scientists	**0.60%**	0.45%	1st in the South, 12th in the U.S.
Computer specialists	**2.25%**	2.24%	3rd in the South (behind TX and VA)
Technical workers	**1.30%**	1.35%	4th in the South (behind AL, TX, and VA)

1st

North Carolina ranks first in the South (12th in the U.S.) with life and physical scientists comprising 0.60% of the state's total workforce. The national average is 0.45%.

Indicator 9: Life and physical scientists as a percent of the workforce

Metric (2011-12): NC: 0.60% *(Ranked 1st in South, 12th in U.S.);* **US: 0.45%**[48]

This indicator (see table above) represents the percentage of life and physical scientists in a state's workforce. Life scientists are identified from standard occupational codes that include agricultural and food scientists, biological scientists, conservation scientists and foresters, and medical scientists. Physical scientists are identified from standard occupational codes that include astronomers, physicists, atmospheric and space scientists, chemists, materials scientists, environmental scientists, and geoscientists.

Indicator 10: Computer specialists as a percent of the workforce

Metric (2011-12): NC: 2.25% *(Ranked 3rd in the South, after VA and TX);* **US: 2.24%**[49]

This indicator (see table above) represents the percent of specialists with advanced computer training in a state's workforce. Computer specialists are identified from 10 standard occupational codes that include computer and information scientists, programmers, software engineers, support specialists, systems analysts, database administrators, and network and computer system administrators. Higher values may indicate a state workforce that is better able to thrive in an information economy or to embrace and utilize computer technology.

Indicator 11: Technical workers as a percent of the workforce

Metric (2011-12): NC: 1.30% *(Ranked 4th in the South, after AL, TX and VA);* **US: 1.35%**

Technical workers include managers in the areas of computer and information science, engineering, or the natural sciences; computer

[48,49] National Science Board Science and Engineering Indicators (2012): State Indicators.

2.13%

The percentage of North Carolina's gross domestic product devoted to R&D is 2.13%, which ranks it 3rd in the South after Alabama and Virginia. The national average is 2.61%.

programmers; drafters working in architecture, civil engineering, electronics, or mechanical engineering; and technicians in a wide variety of technical fields. Individuals who work as scientists and engineers are not included in this indicator. Every state's workforce increased in the number of technical workers from 2004 to 2010. The number of technical workers exceeded the number of doctorate holders, engineers, or life and physical scientists in the workforce during this period.

The next two indicators measure how North Carolina ranks in research and development research and development investments. This sector of the economy encompasses the process whereby any economy enables itself to grow multi-dimensionally. The mission of research and development was the guiding vision for such North Carolina initiatives as the Research Triangle Park, the Biotechnology Center in Concord, the development of SAS into a multi-national software giant, and even NASCAR, where much of the R&D that goes into this national enterprise takes place across Piedmont North Carolina.

Gross Domestic Product

Indicator 12: Percent of research and development as a percentage of gross domestic product

Metric (2009): NC: 2.13% *(Ranked 3rd in the South, after AL and VA);* **US: 2.61%** [50]

This indicator represents the extent to which R&D plays a role in a state's economy. A high value indicates that a state has a high intensity of R&D activity, which may support future growth in knowledge-based industries. Industries that have a high percentage of R&D activity include pharmaceuticals, chemicals, computer equipment and services, electronic components, aerospace, and motor vehicles. R&D performed refers to R&D activities conducted or funded by federal and state agencies, businesses, universities, and nonprofit organizations. In 2009, business performed nearly three-quarters of the total R&D at the national level followed by colleges and universities, at 13 percent, government facilities, including federally funded R&D centers, and nonprofit institutions. The areas in the country most invested in R&D were on the Pacific coast, led by California and Washington, and in the Northeast, led by New Hampshire and New Jersey. The leading R&D state in the country was New Mexico.

Indicator 13: Percent of academic science and engineering research and development per $1,000 of gross domestic product

Metric (2009): NC: 3.91% *(Ranked 1st in South and 5th in the US after MA, MI, ND and NM);* **US: 5.31%** [51]

This indicator represents the ratio of S&E R&D expenditures at a state's colleges and universities to the size of the state's economy. Academic R&D performers account for a little over half of the U.S. basic research, about a third of total research (basic plus applied), and roughly 10 percent of all R&D conducted in the U.S. Academic R&D can be a valuable basis for future economic development.

[50] National Science Board Science and Engineering Indicators (2012): State Indicators.
[51] National Science Board Science and Engineering Indicators (2012): State Indicators. Data on academic R&D are provided by the National Center for Science and Engineering Statistics and represent S&E R&D at U.S. colleges and universities with over $150,000 in R&D expenditures.

The North Carolina Office of Science and Technology

NC Department of Commerce

The NC Office of Science and Technology develops, like many states, regions, and countries, an "innovation index"—a collection of indicators that measure a locale's innovation-related performance relative to specific benchmarks (e.g., other states and countries; regions within a state) and over time. The NC Board of Science and Technology has produced three innovation indexes during the last decade. Indicators typically used in an indexing innovation in NC can include:

* Research and Development
* Commercialization
* Innovative Organizations
* Education and Workforce
* Environment/Infrastructure
* Economic/Prosperity Outcomes

The innovation index compares NC to the region, the nation, and other governmental units. For example, a number of the analyses are based on gross domestic product (GDP), a measure of the overall economic performance of a locale. One purpose of tracking innovation is to examine the relationship between innovation and GDP. When innovation increases, GDP tend to rise. Similarly, when research and development increases, innovation tends to increase, and then so does the potential for increases in GDP.

A fourth index, *Tracking Innovation: North Carolina Innovation Index 2013,* was released in April 2013. An online version of the index is available at: **www.nccommerce.com/scitech/resources/innovation-reports**.

7.82%

The percentage of North Carolina businesses that are classified as "high-tech" is 7.82% which ranks the state 5th in the South. The national average is 8.52%.

High-Technology Business

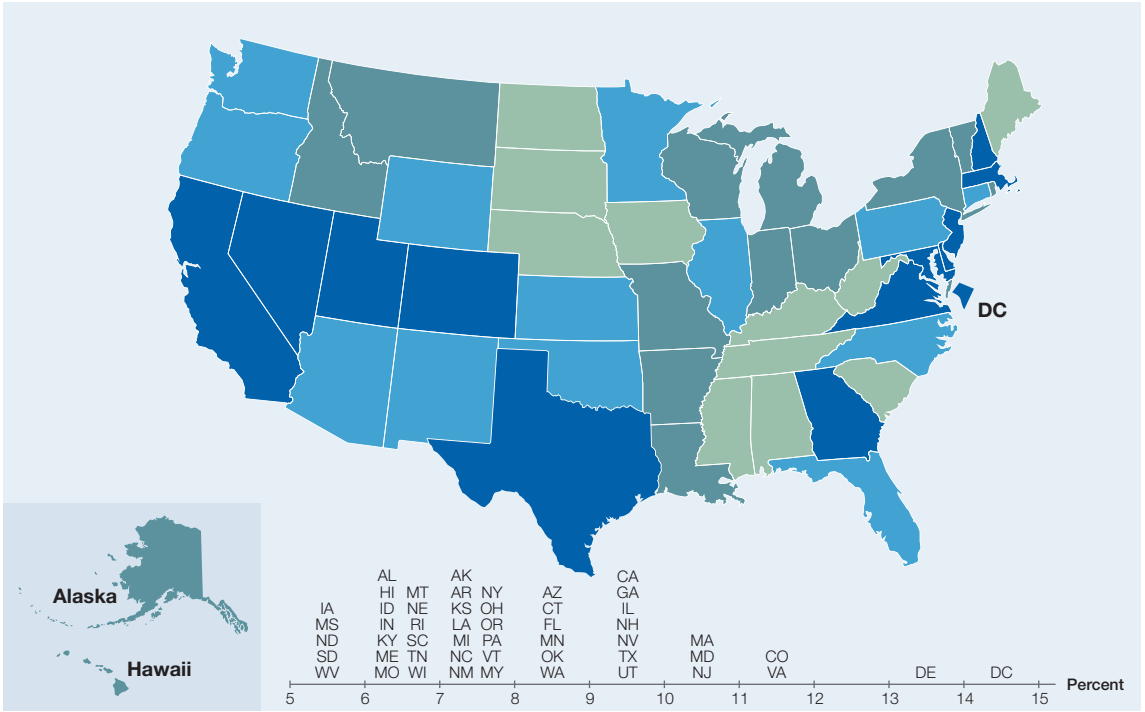
The next two indicators display North Carolina's relative position in terms of high-technology business enterprises, which, in turn, become opportunities for a number of the STEM jobs anticipated for the state's future economic growth. These enterprises are a staple of STEM jobs now and for the remainder of this decade.

Indicator 14: Percent of high technology business establishments as a percentage of all business establishments

Metric (2008): NC: 7.82% *(Ranked 5th in the South, after VA, TX, GA and FL);* **US: 8.52%**[52]

This indicator (see map below) represents the portion of a state's business establishments that are classified as being part of high-technology industries. High-technology industries are defined as those in which the proportion of employees in technology-oriented occupations is at least twice the average proportion for all industries. High-technology occupations include scientific, engineering, and technician occupations that employ workers who generally possess in-depth knowledge of the theories and principles of science, engineering, and mathematics at a postsecondary level. States often consider such industries desirable, in part because they tend to compensate workers better than other industries do.

High-Technology Establishments as a Percentage of all Business Establishments: 2008



1st quartile (9.26%-14.78%) **2nd quartile (7.66%-9.10%)** **3rd quartile (8.88%-7.64%)** **4th quartile (5.19%-6.55%)**

Source: Census Bureau, special tabulations (2011) of 1989-2008 Business Information Tracking Series.

[52] www.nsf.gov/statistics/seind12/c8/interactive/map.cfm?table=52.

Indicator 15: Employment in high-technology establishments as percentage of total employment

Metric (2008): NC: 10.32% *(3rd Quartile in the U.S.; Ranked 4th in South, after VA, TX, GA);* **US: 11.47%**[53]

This indicator represents the extent to which a state's workforce is employed in high-technology industries. As described in the previous indicator, high-technology occupations include scientific, engineering, and technician occupations that employ workers who generally possess in-depth knowledge of the theories and principles of science, engineering, and mathematics at a postsecondary level.

The data pertaining to high-tech establishments are based on their classification according to the 2002 edition of the North American Industry Classification System (NAICS). Data on total employment and NAICS industry establishment employment are provided by the Census Bureau and differ from workforce data provided by the Bureau of Labor Statistics. Total employment refers to all U.S. business establishments with paid employees, but does not include crop and animal production, rail transportation, the postal service, public administration, or most government employees.

Biotechnology

Indicator 16: Employment in biotechnology in North Carolina

Metrics:

1. Among the 10 largest bioscience employer states, **North Carolina's 23.5 percent job growth** *since 2001 has been the fastest.*

2. Five of the 10 largest bioscience employer states, including North Carolina, have a specialized concentration of employment (meets or exceeds a location quotient (LQ) of 1.20 or at least 20 percent of the national average concentration of employment). These five states are: New Jersey (LQ 1.93), Massachusetts (LQ 1.89), Indiana (LQ 1.73), **North Carolina** *(LQ 1.34), and California (LQ 1.26).*

3. Compared with other top bioscience states, from the economic peak in 2007 through the recession and initial year of recovery in 2010, **North Carolina was just one of four states to have increased employment.**[54]

To compare North Carolina to other states, the ScoreCard used the Biotechnology Industry Organization's (BIO) definition of the bioscience industry that was developed jointly with Battelle, based on selected North American Industry Classification System sectors and measured by industry employment levels reported in the Bureau of Labor Statistics Quarterly Census of Employment and Wages. North Carolina stands out in its rapid growth in the biosciences over the past decade, even compared with national leaders in this sector, like California, Massachusetts and New Jersey.

Internet Broadband Access

The next two indicators relate to the capacity of North Carolinians to have clear access to the Internet and broadband technology. This access is a critical part of providing the technological tools for life in the 21st century. Most STEM jobs require facile and adaptive knowledge and skills in a sector of our lives that is constantly changing.

23.5%

North Carolina's 23.5 percent job growth in bioscience since 2001 has been the fastest among the 10 largest bioscience employer states.

[53] www.nsf.gov/statistics/seind12/c8/interactive/map.cfm?table=54.

[54] North Carolina Biotechnology Center. http://www.ncbiotech.org – 2012 Evidence and Opportunity: Impacts of the Biosciences in North Carolina. Prepared for NC Biotechnology Center by Battelle Technology Partnership Practice. January 2013 www.ncbiotech.org/sites/default/files/articles/NCBiotech_2012_full_report_DRAFT__1.29.13_% 5B1%5D.pdf.

65.10%

North Carolina ranks 38th in the U.S. and fifth in the South with 65.10% of households having Internet and broadband access. The U.S. ranks 15th in the world with 67.95% broadband adoption.

Indicator 17: Percent of households with Internet broadband access[55]

Metric (2010): NC: 65.10%; US: 67.94%

North Carolina ranks 38th in the U.S. and fifth in the South in the percentage of households with Internet and broadband access, after Florida, Virginia, Georgia, and Texas. On a larger scale, the United States is 15th in the world in broadband adoption.

Indicator 18: Average Internet download speed (Mbps Index)[56]

Metric (2011-12): NC: 13.06%; US: 15.56%

On measures of Internet speed, North Carolina ranked ninth in the South after Virginia, Florida, Tennessee, Georgia, Alabama, South Carolina, Louisiana, and Texas, and only higher than Mississippi. In 2009 North Carolina ranked 15th in U.S., indicating that it is not progressing in expanding high speed Internet access at the rate of many other states. The U.S. ranked 34th globally. South Korea, Japan, Sweden and even Romania have much faster Internet connections than the United States.

Domain Summary

Several insights can be drawn from the results of these 18 indicators. Perhaps first and foremost, when considering readiness for the economic productivity of the future, North Carolina generally ranks high among Southern states, often in second or third place. Given the competitive nature of STEM jobs in the South, this position is adequate but also promising.

On nearly all indicators, Virginia ranked higher than North Carolina. Since NC shares a border with Virginia, this puts it in a particularly competitive position for both talent and job growth. North Carolina competes with a broader area than the South, however. Out of 18 indicators, North Carolina lagged behind the U.S. score on 11. Several other states, particularly in the upper Midwest and the Northeast, are making larger investments in STEM education and job creation, cultivating favorable environments for investment.

On the national scale, states showing a greater number of jobs requiring postsecondary education are likely to have higher powered economic engines, fueled by more higher paying jobs, including STEM jobs. In fact, a 17 percent increase in STEM jobs is anticipated by 2018, not including growth in the medical and allied health occupations. The occupational areas anticipated to grow most rapidly include jobs in medical and allied health, and computer technology.

North Carolina's rankings on the indicators, along with data on employment and growth opportunities, reveal a clear picture of the state's preparedness and capacity for strengthening STEM education and expanding STEM career opportunities, as well as how the state compares to the rest of the country.

* By 2018, there will be approximately 1.4 million job vacancies in North Carolina, either from new job creation or from retirements. Of those vacancies, about 833,000 will require some postsecondary education.
* Approximately 59 percent of all jobs (2.9 million) in 2018 in North Carolina will require postsecondary education. The lion's share of the state's economic engine will be fueled by these jobs.
* North Carolina will have more job growth requiring postsecondary education than most of the South and Southwest.
* The growth potential for jobs in medicine and related allied health professions in North Carolina will be significant. Many in the medical and allied health fields will be retiring over the next five to seven years. The general aging of the state's population will increase the need for not just primary care practitioners (physicians, nurses, physician assistants, nurse practitio¬ners), but also for ancillary health care services (therapists, audiologists, clinical laboratory technicians, dental technicians). However, North Carolina lags behind the nation in the number of medical students per 100,000 in population and lags behind all of its Southern neighbors except Georgia.

Action Items

1. **Develop a STEM-focused strategic plan to guide state policy in making North Carolina more educationally and economically competitive.**
2. **Assess STEM workforce opportunities and barriers with the goal of expanding opportunity and economic development more fully across the entire state and across all demographic groups.**
3. **Create a Council on the Future of Economic Growth and the Quality of Life to chart a path to a more prosperous, creative and livable North Carolina.**

STEM Preparation for All. How well prepared is North Carolina to enable its young citizens to compete for and succeed in securing good paying STEM jobs? The state's priority must be that every child is given the tools and the opportunities to learn and grow in these knowledge areas. The state must also devise strategies to attract and retain students from previously underrepresented populations to ensure equitable geographic distribution of these opportunities. Populations that are underrepresented in STEM fields—academically and occupationally—make up over 40% of the 15-34 year-old age demographic. In the next five to seven years, these students will comprise a sizeable proportion of the population seeking jobs. Providing these young people with the knowledge, skills, and credentials in STEM fields will enable them to compete for the jobs that will drive a revitalized and robust North Carolina economy. The state will reap a good return on its investment as these students become contributing members of the workforce in STEM fields that will fuel the economy and elevate the standard of living for all citizens.

By 2018, North Carolina will have more job growth requiring postsecondary education than most of the South and Southwest. The occupational areas anticipated to grow most rapidly include jobs in medical and allied health, and computer technology.

DOMAIN TWO:

Informal Education and STEM Literacy

The goal: Create greater access to and participation in STEM-related learning outside formal school settings.

Researchers contend that a major advantage enjoyed by the U.S. relative to the rest of the world is its vibrant landscape filled with a multitude of learning opportunities: museums zoos, aquariums, local state and regional parks, and afterschool activities activities such as Boys and Girl Clubs and scouting, plus widespread access to the Internet, educational television and libraries. Studies show that much of the science knowledge of young school-age learners is actually acquired outside of school. Studies also show that informal and free-choice learning contributes significantly to career choices and to the continuous lifelong learning and STEM literacy of adults.[57]

Given the significance of these findings, the STEM ScoreCard has documented how comprehensively these opportunities are available to and being utilized by students as well as teachers, families and other adults across North Carolina. The metrics generated are largely participation numbers by students, teachers and the general public, since other impacts are exceedingly difficult to assess beyond structured and limited research efforts.

The engagement of students in state-level STEM competitions, like MathCounts or the NC Science, Engineering and Technology Fair, helps focus and sustain student engagement in STEM. Such specialized competitions offer a unique opportunity for students who have the interest and talent to extend their engagement and further develop their talents and capacity in STEM. Research on students participating at ever-higher levels of STEM competitions shows high incidences of students pursuing STEM disciplines in college and STEM-field careers as well.[58] stem competitions throughout the state are essential to the overall goal of advancing a STEM-ready workforce in North Carolina.

Studies show that much of the science knowledge of young school-age learners is actually acquired outside of school.

[57] Falk, J.H. and Dierking, L.D. (2010). *The 95 Percent Solution: School is not where most Americans learn most of their science.* American Scientist, v98, n6, November-December, Sigma Xi.

[58] Kenderov, P.F. (2006). Competitions and Mathematics Education. Proceedings of the International Congress of Mathematicians, Madrid, Spain pp.1583-1598. www.icm2006.org/proceedings/Vol_III/contents/ICM_Vol_3_76.pdf.

3.65 million

The NC Grassroots Science Museum Collaborative has 34 member museums that serve all 100 North Carolina counties and attracts 3.65 million visitors annually, nearly 11,000 daily.

The developers of the NC STEM ScoreCard know of no comprehensive collections of informal education opportunities specific to North Carolina. Consequently, data for this domain do not represent the full extent of participation in informal learning activities in North Carolina. Some of the metrics likely include duplicated participation as well.

The key question is: Do students, teachers, parents, and other adults have access to and participate in STEM-related learning outside of formal school settings, in STEM-related museums and learning centers, afterschool and summer enrichment programs, competitions, digital learning, and other forms of self-directed STEM learning?

NC Grassroots Collaborative[59]

Indicator 1: Attendance for all North Carolina Grassroots Science Collaborative Museums

Metric (2011-12): **3,774,949** *total participants*

The NC Grassroots Science Museum Collaborative (NCGSMC) was created in 1991 and is the only statewide collaborative of science museums in the U.S. Its purpose is to inspire and educate the state's children and adults in the STEM fields, and to help prepare the next generation of scientists, engineers, mathematicians, educators, and others by helping them to achieve a strong foundation in STEM knowledge. NCGSMC has 34 member museums that serve all 100 North Carolina counties and attracts 3.65 million visitors annually, nearly 11,000 daily. The 34 Grassroots museums are large and small and located in communities across the entire state. Grassroots members include the Morehead Planetarium and science center, the NC Museum of Science in Raleigh, Discovery Place in Charlotte and the Museum of Life and Science in Durham.

Total Grassroots expenditures approximate $47,600,000, through receipts, grants and contracts generated by the museums. The NC General Assembly supports 5.8 percent of the Grassroots Museums budget, ($2,773,043).

Indicator 2: Number of K-12 students participating in STEM-related programs offered onsite and off-site by local and state science museums

Metric (2011-12): 1,889,198 *(on-site);* **478,829** *(off-site);* **2,368,027** *total students*

Indicator 3: Number of K-12 teachers participating in professional development programs offered by NC museums

Metric (2011-12): 4,343 *total K-12 teachers*[60]

The totals in Indicators 2 and 3 reflect only Grassroots museums. Many other STEM-related organizations in North Carolina that are not members of Grassroots include the NC Botanical Gardens in Chapel Hill and the Wright Brothers Memorial at Kitty Hawk. Participation figures for the NC Zoo and the three NC Aquariums are totaled separately below.

[59,60] www.ncscience.org/ and data for Indicators 2 and 3 November 26, 2012 e-mail correspondence with Stephen Saucier, Executive Director, NC Grassroots Science Museums.

NC Aquariums[61]

Indicator 4: NC Aquarium attendance

Metric (2011-12): 1,104,200 *total attendance*

Indicator 5: Number of K-12 students participating in STEM-related programs offered by NC Aquariums

Metric (2011-12): 62,711 *total K-12 students*

Indicator 6: Number of K-12 teachers participating in professional development programs offered by NC Aquariums

Metric (2011-12): 145 *total K-12 teachers*

The North Carolina Aquariums were established in 1976, during the term of Governor James Holshouser, Jr., to promote an awareness, understanding, appreciation and conservation of the diverse natural and cultural resources of North Carolina's ocean, estuaries, rivers, streams and other aquatic environments. NC Aquariums is a system of three public aquariums located in Kure Beach, Roanoke Island and Pine Knoll Shores.

The NC Zoo[62]

Indicator 7: NC Zoo total attendance

Metric (2011-12): 761,964 *total attendance (highest attendance recorded in 15 years)*

Indicator 8: Number of K-12 students participating in STEM-related programs offered by the NC Zoo

Metric (2011-12): 105,637 *K-12 Students*

Indicator 9: Number of teachers participating in professional development programs offered by the NC Zoo

Metric (2011-12): 1,190 *total teachers*

The North Carolina Zoo is located just south of Asheboro and is seated on a 1,500-acre tract of land in the Uwharrie Mountains. Approximately 500 acres of this property have been developed into one of the largest natural habitat zoos in the United States. Animals in the NC Zoo are housed in enclosures that mimic their natural habitats that include trees, ponds, rocks, grass and dirt. The North Carolina Zoo grew from an idea initiated by the Raleigh Jaycees in 1967. Through a series of fund-raising events—including at least one professional football game—the site was selected and secured In Randolph County to be close to the center of the state. The first exhibits opened in 1974 as part of a temporary facility while the permanent zoo was being built. The first permanent exhibit, which opened in 1979, was "Forest Edge," home to zebra, ostrich and giraffe.

761,964

The NC Zoo had a total attendance in 2011-12 of 761,964—the highest recorded in 15 years.

[61] www.ncaquariums.com and data for Indicators 4, 5, & 6, November 20-21, 2012 e-mail correspondence with Patricia Raves, Education Curator, NC Aquarium on Roanoke Island; Jennifer Metzler, Education Curator, NC Aquarium at Ft. Fisher; and Windy Arey-Kent, NC Aquarium at Pine Knoll Shores.

[62] www.nczoo.org/about/index.html and for all data shown for Indicators 7, 8, & 9, November 27, 2012 e-mail correspondence from Randy Fulk, Curator of Education, NC Zoo in Asheboro.

5,641,113
Total attendance at Grassroots Collaborative Museums, the NC Zoo and NC Aquariums in 2011-12 was 5,641,113 visitors. Even accounting for duplicate and out-of-state visitors, this indicates a serious commitment to STEM learning in North Carolina.

Totals for Grassroots Collaborative Museums, NC Zoo and NC Aquariums

Indicator 10: Attendance, Grassroots Collaborative Museums, NC Zoo and NC Aquariums

Metric (2011-12): 5,641,113 *total attendance*

Indicator 10 summarizes attendance data of indicators 1-9 in this domain. The total—5.6 million people—represents over half of the entire North Carolina population. Even accounting for out-of-state visitors in these totals, these data clearly indicate a serious commitment to STEM learning in North Carolina.

Indicator 11: Number of K-12 students participating in STEM-related programs offered by the science museums, NC Zoo and NC Aquariums

Metric (2011-12): 2,536,375 *total K-12 students*

Indicator 11 demonstrates the potential for STEM engagement since most of these programs take place during school excursions. This particular metric is nearly twice the total K-12 student enrollment in North Carolina. It is apparent that schools and teachers value these opportunities to engage students in informal stem learning, and can tie these experiences to classroom lessons.

Indicator 12: Number of K-12 teachers participating in professional development programs offered by the science museums, NC Zoo and NC Aquariums

Metric (2011-12): 5,678 *total K-12 teachers*

The number of teachers who participated in professional development activities at these settings appears to represent no more than five percent of all teachers in North Carolina. Nevertheless, these teachers pursued these learning opportunities on their own to advance their knowledge and skills.

Note: The totals in Indicators 1-12 do not include the total participation by students, teachers and others at many of the 212 STEM-related museums, outdoor education facilities and science programs not in the Grassroots Collaborative Network but which are noted on the NC DENR Office of Environmental Education and Public Affairs website: www.eenorthcarolina.org/index.asp. The DENR Office of Environmental Education was established in 1993 under Governor Martin's administration to balance the department's regulatory functions with a commitment to environmental literacy and environmental education outreach.[63]

A February 2013 survey of these organizations reported that 100% of the respondents provide programs for students, teachers and the general public. Other organizations include the Great Smoky Mountains National Park, one of the top visitor attractions in the United States, and the Harris Energy and Environmental Center near Charlotte. Participation data for state parks and recreational areas are reported in Indicator 14.

[63] http://portal.ncdenr.org/web/guest.

Indicator 13: Randomized survey of adults who visited a science museum or center, aquarium, zoo or planetarium in the last year

Metric (2011-12): 48%, *222 of 467 responses indicated visitations to one or more of the informal learning facilities listed above.*[64]

North Carolina State Parks and Recreational Areas

Indicator 14: NC state parks and recreational areas attendance

Metric (2011-12):[65] **14,250,000** *total attendance*

This total matches all-time high attendance set in 2009. The state parks system manages more than 215,000 acres and produces an estimated $400 million in economic benefits to the state.

Indicator 15: Number of students engaged in service learning projects within the NC state parks

Metric (2011-12):[66] **Approximately 100,000** *students*

The following table summarizes the data reported in the first 15 indicators of the STEM Literacy and Engagement domain.

14,250,000
Total attendance at NC state parks and recreational areas was 14.25 million in 2011-12, matching the all time high.

Summary of Participation in Informal Learning

Type of Institution	Participation	Notes
State and Local Science Museums (Grassroots Collaborative)	**3,774,949**	2,368,027 children participated in STEM programs
State Aquariums	**1,104,200**	62,711 children participated in STEM programs
North Carolina Zoo	**761,964**	105,637 children participated in STEM programs
Total for Museums, Aquariums, Zoo	**5,641,113**	2,536,375 children participated in STEM programs
4-H	**151,371**	STEM Programs sponsored by 4-H
Supplemental and/or Afterschool Programs	**179,874**	Represents 12% of total K-12 student population
Total for Afterschool Programs	**331,245**	Represents nearly 24% of total K-12 student population
North Carolina Parks and Recreation	**14,250,000**	100,000 children participated in service learning projects

[64] The Morehead Planetarium and Science Center authorized an Elon University poll for the NC Science Festival Market Research Survey. The scientific sampling of North Carolinians, with equitable distribution by geography, race, gender, level of education and income was completed on September 25, 2012. Survey participation by Area Code: 252 = 44%; 336 = 55%; 704/980 = 48%; 828 = 44%; 910 = 43%; 919/984 = 53%. The more rural regions (area codes 252, 828 & 910) had the lowest reported attendance rates at the museums, aquariums, zoo and planetarium of any others across the state.

[65,66] North Carolina State Parks and Recreation, http://ncparks.gov/News/media_room/docs/2012_annual_rpt.pdf.

331,245

The combined total for PreK-12 participation in STEM-related afterschool programs is 331,245 students, which includes NC 4-H programs as well as those offered by non-school providers.

Supplemental or Afterschool Programs

In 2011, the NC STEM and After School Alliance released *STEM Learning in Afterschool: An Analysis of Impact and Outcomes*, a review of evaluations of afterschool time and summer programs. The report findings indicate that attending high-quality STEM afterschool programs yielded benefits that can be organized under three broad categories: (1) improved attitudes toward STEM fields and careers; (2) increased STEM knowledge and skills; and (3) a higher likelihood of graduation and pursuit of a STEM career. The largest statewide provider of afterschool STEM education is 4-H, reported separately below.

Indicator 17: Number of PreK-12 students participating in within-school and/or NC 4-H afterschool STEM-related programs

Metric (2011-12):[67] **151,371** *students (2012)*

In 2012, NC 4-H STEM programs and curriculum served grades 2-7 and were aligned to the new Common Core and Essential Standards.

Indicator 18: Number of and percentage PreK-12 students participating in within-school and/or afterschool STEM-related programs by non-school providers

Metric (2011-12):[68] **179,874** *students*

Participation levels on Indicator 18 represent a number equal to 12 percent of the K-12 student population in NC. On average, participants spend 10 hours per week in afterschool programs. Participation averages three days per week. Though incorporating a much broader survey of providers, there may be some duplication of this data with 4-H data. The total participation in all STEM-related afterschool programs is **331,245 students**.

Student Competitions

This section of the domain analysis focuses on student competitions in both mathematics and the sciences. By the nature of these competitions, the magnitude of the numbers is not as important as the quality of the participants. However, increasing participation levels is generally regarded as a means to attract and develop more talent. The first part focuses on mathematics competitions.

Indicator 19: Number of student participants in mathematics competitions (aggregated across competitions)

Metric(s) (2010-11):[69]

Math Counts – Middle School Competition: 1,674 *students (seventh in student participation nationally)*

NC High School Mathematics Competition: Approximately 5,000 *students*

In 2012, based on the rules for advancing to the state finals in the Comprehensive Math division, over 1,000 students from over 100 NC schools participated. Beyond the comprehensive division, there are also divisions in Algebra I, Algebra II, and Geometry. Another 4,000 students are estimated to have participated in division competitions prior to state finals.

The American Mathematics Competitions (AMC) and Math Olympiad: 5,091 *students*

The American Mathematics Competitions began in 1950 with the American High School Mathematics Exam (AHSME). In 1983 the American Invitational Mathematics Exam (AIME)

[67] North Carolina 4H Youth Development, www.nc4h.org.
[68] NC Center for Afterschool Programs, www.ncforum.org/initiatives/nccap.aspx.
[69] North Carolina State High School Mathematics Contest, North Carolina Council of Teachers of Mathematics. http://mathcounts.org/Page.aspx?pid=1556; America Math Competitions, North Carolina Results 2010, http://courses.ncssm.edu/goebel/state-con/state.htm, http://math.uncc.edu/~hbreiter/AHSME/Report2010.htm.

Summary of STEM-Related Student Competitions

Math Competitions	Participation	Notes
Math Counts	**1,674**	Middle School
Math Counts	**5000***	High School
American Mathematics Competition/Math Olympiad	**5,091**	NC in top 10 for five consecutive years
American Regional Mathematics League	**30**	National competition; NC twice national champion
Total	**11,795**	

* Approximate.

Science Competitions	Participation	Notes
NC Science/Engineering Fair	**1,283**	Participation number is only for middle grade and high school students who competed in the state-level science fair and does not include the many thousands of students who participated in local science fairs for which reliable numbers are not available.
Science Olympiad	**10,869**	Participation number is for all students who participated in state-level regional competitions plus those who proceeded to U.S. regional competitions and to the International Competition.
FIRST Robotics, FIRST Tech, and LEGO competitions	**3,268**	These fee-based competitions include students in grades 4-12.
NC Academy of Science	**141**	This selective competition includes middle school and high school students.
National Youth Science Competition	**3,500**	4-H sponsored
Junior Science and Humanities Symposium	**65**	This competition is a collaboration with the Department of Defense.
Total (selected competitions)	**19,126**	

Top 10

NC is the only state to place students in the top 10 for five consecutive years in the American Mathematics Competitions.

was initiated for students scoring 100 or higher on the AHSME. In 1986, the American Junior High School Mathematics Exam (AJHSME) was introduced. In 2000, the names of the AJHSME and AHSME were changed to AMC8 and AMC12, and a new AMC10 test, designed for students up to and including grade 10, was introduced. Increasingly selective groups of AIME participants are invited to the USA Mathematical Olympiad, the Mathematical Olympiad Summer Program, and finally, to represent the U.S. in the International Mathematical Olympiad. NC students participated in the various levels of AMC competition during 2010, the most recent year for which final statistics are available. NC is the only state to place in the top 10 for five consecutive years.

10,869
North Carolina had 10,869 total preK-12 participants in the Science Olympiad in 2011-12. Students came from 68 counties and included 452 schools and 631 teams.

American Regions Math League (ARML) National Competition: 30 *students (approximately)*

ARML is a nationwide contest to which each region sends one or more teams; over 100 teams compete each year. North Carolina routinely sends two teams of 15 students each who are easily NC's top math students. The NC team has performed very well in recent years, taking home two national championships (in 2006 and 2012) and a second place prize in 2013. It is the only team in the nation to place in the top 10 every year from 2006 to 2012.

Total participation for the mathematics competitions cited in Indicator 19 is nearly **11,800 students**.

Indicator 20: Number of student participants in distinctive science, engineering, technology or cross-disciplinary STEM competitions (aggregated across providers)

Metric(s) (2011-12):[70]

NC Science and Engineering Competition: 1,283 *students*

This number reflects only those students participating in one of the 10 Regional Science and Engineering Competitions and does not include students who participated in local school or district Science and Engineering Fairs and who did not qualify to advance to one of the 10 Regional Competitions.

Science Olympiad: 10,869 *students*

Participants from 68 counties included 452 schools, 631 teams (10,869 total students: 2,445 elementary, 4,302 middle school, 4,122 high school), approximately 1,800 coaches (teachers, parents, school administrators), and more than 2,500 volunteers. More than $250,000 in scholarships is awarded and over 380 teachers receive professional development.

Odyssey of the Mind: 3,300 *students (approximately)*

Odyssey of the Mind (OM) is an international educational program that provides creative problem-solving opportunities for students from kindergarten through college. Teams of five-seven members apply their creativity to solve problems that range from building mechanical devices to presenting their own interpretation of literary classics. Teams bring their solutions to competitions on the local, state, and world levels. Competitions occur across NC in five regions leading up to the state competition in April. Winners advance to national and international competitions.

First Robotics: 1,260
First Tech: 360
First Lego: 1,648
Total: 3,268 *students*

FIRST Robotics is a high-school-level competition, FIRST Tech is for grades 7-12, and FIRST Lego is a grades 4-8 competition. All are open to public, private and home-schooled students. FIRST (For Inspiration and Recognition of Science and Technology), a multi-national 501(c)(3) nonprofit organization, was founded in 1989 by inventor and entrepreneur Dean Kamen. FIRST's programs build upon Dean's vision that culture can be positively transformed by inspiring young people, their schools and communities to appreciate science, technology, engineering, and mathematics.

[70] North Carolina Science, Mathematics, and Technology Education Center, Newsletter, March 2010, www.ncsmt.org/newsletter.php?action=Detail&id=470&categoryid=3; NC Science Olympiad, www.sciencenc.com/; NC Odyssey of the Mind, www.ncom.org/; NC First Robotics, www.ncfirstrobotics.org/; NC Academy of Science, www.ncacadsci.org/; Junior Science and Humanities Symposium, www.jshs.org/.

North Carolina Academy of Science: 141 *students*

The North Carolina International Science Challenge (NCISC) is a yearly science competition offered jointly by the Grassroots Science Museums Collaborative, the North Carolina Science, Mathematics and Technology Education Center and the Morehead Planetarium and Science Center. Participants must be U.S. citizens presently enrolled in high school. Several excellent inquiry-based science projects are chosen; student creators display their projects at the Beijing Youth Science Creation Competition (BYSCC), held during the third week of March in Beijing, China. The students chosen through the NCISC process are the sole representatives of the United States of America.

National Youth Science Competition: 3,500 *students (approximately)*

The annual 4-H National Youth Science Day (NYSD) is the premier national competitive event for year-round 4-H science programming, bringing together youth, volunteers and educators from the nation's 111 land-grant colleges and universities to simultaneously complete the National Science Experiment. For the 2012 4-H National Youth Science Competition experiment, the Eco-Bot Challenge, students learned to think like robotics engineers, assembling their own robots—known as Eco-bots—and control surfaces in order to determine the most effective environmental clean-up solution for a simulated toxic spill.

Junior Science and Humanities Symposium: 65 *students*

Junior Science and Humanities Symposium (JSHS) is a collaborative effort with the research arm of the Department of Defense and administered in cooperation with colleges and universities nationwide to prepare and support students to contribute as future scientists and engineers —conducting STEM research on behalf of or directly for the Department of Defense, the federal research laboratories, or for the greater good in advancing the nation's scientific and technological progress. UNC-Charlotte and The Science House at NCSU now alternate hosting this prestigious competition. In 2011 there were 50 competitors and 15 student observers, plus teachers, parents, judges and speakers.

Well over 19,000 students participated in these science competitions. When participation rates are combined across all competitions cited in indicators 19 and 20, nearly 35,000 North Carolina students participated in STEM-related local, state, national, and international competitions.

Indicator 21: Access to and range of the distinctive UNC-TV STEM programming[71]

Metric(s): *Overall use and value*

* **77.7%** of North Carolinians said UNC-TV's service is either "very important" or "important" in a statewide Elon Poll.
* North Carolina families watch more than **39 million viewer-hours** of UNC-TV's children's programs annually.

35,000

When participation rates are combined across all competitions cited in indicators 19 and 20, nearly 35,000 students participated in STEM-related local, state, national, and international competitions.

[71] www.unctv.org/content.

39 million
North Carolina families watch more than 39 million viewer-hours of UNC-TV's children's programs annually.

* Research shows children who watch public television children's programs do better in school and in life.
* UNC-TV is North Carolina's source for PBS STEM-related programs like *Nova*, *Nature Life on Fire*, *The History of Science*, *Quest*, and *Carolina Outdoor Journal.*
* UNC-TV is the only available North Carolina-based television broadcast service in some areas.

Metric(s): *Collaborations to develop free-choice use and instructional programs*

* **Quest** is a project designed to provide quality media on science and the environment, incorporating 21st century skill development and media production. Quest brings together partners from the science and environment community—universities, research centers, educators and museums—to assist with their work. Quest incorporates the work of five public television organizations, creating content across platforms, including broadcast programs, digital storytelling, radio reports, free educator resources, blogs, crowd-sourced digital content and more.
* **PBS KIDS Lab** is a project of PBS that works closely with researchers and advisors to build curriculum frameworks that ensure all content aligns to state and national standards. The Lab includes instructional games and mobile apps from beloved characters like Curious George, The Cat in the Hat, Buddy from Dinosaur Train, Sid the Science Kid, and more. A Math Skill Wheel enables teachers and parents to find games by skill and age group. PBS KIDS Lab has games for children ages 3 to 8.
* **PBS TeacherLine**, online professional development courses for teachers, offers over 30 courses covering diverse topics in STEM subjects. Teachers can pursue continuing education or graduate credit, and also can complete courses in full ISTE NETS-T alignment for the ISTE Certification Program. PBS TeacherLine courses range from 15 hours to 45 hours of rigorous, facilitated courses, and are approved in 106 of North Carolina's 115 Local Education Agencies. Additional information about PBS TeacherLine is available at www.unctv.org.

Domain Summary

The citizens of North Carolina appreciate these resources as evidenced by their participation in the assortment of informal learning opportunities offered throughout the state. All of the indicators presented above illustrate a wide variety of opportunities and venues with high rates of participation by students and adults. Those participation levels serve the development of STEM engagement and literacy quite well.

However, there are no data or data sources that can disaggregate these figures to indicate how the participation rates are representative of North Carolina's population geographically, racially, ethnically, or by income level. Having a means to know how these numbers reflect the participation of all North Carolinians would be helpful in assessing unmet needs and interest.

Furthermore, all of the venues, programs, and opportunities included in this domain are state agencies or belong to a statewide network of kindred institutions. Any number of more localized settings, that are neither statewide in their

scope nor a part of an organized network of similar institutions, may exist. Other more localized STEM initiatives in higher education settings may not be a part of these networks as well. These STEM-focused initiatives may be accomplishing great things relative to STEM engagement and literacy, but we have no systematic way of knowing.

Action Items

1. **Extend STEM engagement opportunities to children, students, and adults across the state and expand professional development opportunities for STEM teachers and others through collaborative networks.**
2. **Assess the impact of informal education experiences, afterschool programs, and student competitions on student learning and STEM engagement.**
3. **Expand networking and sharing of STEM resources and data across informal learning and afterschool providers.**

North Carolina has long recognized that all learning, including STEM learning, occurs well beyond lessons in classrooms and laboratories in both public and private schools and colleges and universities. The breadth of venues and programs represents this state's commitment to out-of-school learning. Opportunities exist for any North Carolinian to learn more about his or her world, related to STEM or otherwise. North Carolina is a national leader in that regard.

The primary challenge in this area of the ScoreCard is to ensure provision of the means and commitments to maximize access and opportunity across all lines: geographic, socio-economic, gender, and ethnic. The state's objective, and that of all STEM providers in the state, should be to devise a plan to coordinate, integrate and track all efforts to ensure that STEM opportunities are abundant for all North Carolina citizens. Now is the time for the state to adequately prepare for the upcoming decade of career and economic opportunities in science, math, technology and engineering.

PBS TeacherLine offers online professional development courses for teachers, with over 30 rigorous courses covering diverse topics in STEM subjects.

DOMAIN THREE:

Strategic Investments and Innovation

The goal: Build STEM knowledge and skills in schools, students, teachers and communities across North Carolina with unique programs.

This domain focuses on programs, initiatives and other efforts that serve the entire state of North Carolina, encompassing areas from early childhood to the workforce, with formal and informal STEM learning along the way.

The key question is: In what ways does the state sponsor and/or otherwise support additional investments and innovations directed at STEM learning, from both public and non-public sources? In seeking the data to answer this and other questions, we found a number of national-class innovations that have bolstered North Carolina's position of leadership and creativity in STEM-focused initiatives.

The first innovation is NC's long-standing investment in early childhood education. While this initiative is not without its detractors, overwhelming research evidence indicates that pre-kindergarten and kindergarten experiences for 4- and 5-year olds pays positive dividends in ongoing student achievement, student conduct, and socialization.[72]

Indicator 1: Quantity and quality of early childhood education for 4-year olds

Metric (2011-12): Quantity: *24% of 4-year olds were in public-funded early childhood education programs in 2011, a 1% decline from 2009 and 2010. NC ranks 19th in the U.S. for 4-year olds served.*[73]

Metric (2011-12): Quality: *NC meets 100% of standards; 10 of the 10 professionally recognized Quality Standard Policy Domains: Early learning standards, Teacher degree, Teacher specialized training, Assistant teacher degree (public); CDA (nonpublic), Teacher in-service, Maximum class size, Staff-child ratio, Screening/referral, Meals, Monitoring (National Institute for Early Childhood Research)*[74]

STEM education does not begin with formal schooling in the elementary grades. The foundations are established for all learning, including STEM learning, from birth. The natural curiosity of infants and toddlers, if nurtured, are the building blocks for the cognitive and emotional development

100%

In 2011-12, North Carolina successfully fulfilled 10 of the 10 professionally recognized Quality Standard Policy Domains in early childhood education for 4-year olds.

[72] Reynolds, A.J., Temple, J.A., Robertson, D.L., & Mann, E.A. (2001). Long-term effects of an early childhood Intervention on educational achievement and juvenile arrest: A 15-Year follow-up of low-Income children in public schools. Journal of the American Medical Association (285:18): http://jama.jamanetwork.com/article.aspx?articleid=193816.

[73] www.nieer.org/sites/nieer/files/North%20Carolina.pdf.

[74] www.nieer.org/yearbook.

$159 million

North Carolina is making a long-term but potentially high-yield investment through its support of early learning. In 2011, the total NC state pre-K spending was $158,928,389.

that can mature into more formal individual and collaborative inquiry as youngsters mature. Thus, a long-term, but potentially high-yield, investment is the support that North Carolina is making in early learning. In 2011, the state spent a total of $158,928,389 in pre-K education. The primary rationale for public investment in early childhood education (ECE) are the benefits that accrue to society beyond the personal gains and advantages to child and family—which are substantial. Private benefits include increased school success and educational attainment, improved health, and higher after-tax earnings. Social benefits related to ECE are decreased costs of public education, improved classroom climate and learning from peers (because some children are better behaved, and children learn from each other), decreased health care costs, reduced crime and violence, higher tax revenues, greater economic growth due to productivity enhancements, and decreased social and economic inequalities.[75]

Indicator 2: STEM informational and instructional services of UNC-TV

Metric(s) (2012): Public access and use[76]

* UNC-TV is the most used state tax-supported service after the road system.
* UNC-TV's services cost just $1.00 per North Carolina citizen per year.
* UNC-TV is part of North Carolina's emergency communications infrastructure, partnering with state and local public safety agencies.
* In 2012, UNC-TV produced 340 hours of original programming, such as *North Carolina Now*, *Legislative Week in Review*, and *North Carolina Weekend.*

Metric (2012): Learning resources for students, teachers, families, and public[77]

* **Student enrollment** in distance-learning telecourses has grown to nearly 20,000, and original production of North Carolina programming has increased from 183 hours in 1992 to more than 400 hours today.
* **UNC-TV digital resources for teachers:** UNC-TV LearningMedia aggregates the highest quality educational content from public media producers, delivering a next-generation digital media platform for preK-12 classrooms. With thousands of curriculum and professional development resources from leading educational producers, UNC-TV

[75] *Investing in Early Childhood Education: A Global Perspective*, W.S. Barnett and M. Nores National Institute for Early Education Research, November 2012 www.nieer.org/publications/presentations/investing-early-childhood-education-and-care.

[76,77] www.unctv.org/content and December 19, 2012 e-mail communication with Diane Lucas.

LearningMedia provides customized solutions to support classroom needs. STEM resources, which include contextualized video, instructional interactives, images, audio, print and lesson plans, are available free to educators and homeschoolers in UNC-TV LearningMedia: 4,052 Science Resources, 238 Technology Resources, 489 Engineering Resources, 820 Math Resources.

The UNC-TV mission statement reads: *Television has the power to change lives. Public television has the responsibility to changes lives for the better: a child far from urban resources is inspired to become a scientist, a high school dropout earns a GED, a homebound senior citizen remains connected to the world of arts and culture, the family of an Alzheimer's patient finds strength and support. UNC-TV's unique programs and services provide people of all ages with enriching, life-changing television.*[78]

From its beginning, in 1955, as WUNC-TV Channel 4 on the campus of the University of North Carolina at Chapel Hill, UNC-TV is now a statewide public television network with 11 transmitters assuring that virtually 100% of North Carolinians have access to a family of digital public television services. Through the specialized digital channels, significant numbers of STEM programs and resources are freely accessible to and being heavily used by teachers, students, schools, adults, families for formal and guided learning and for general interest viewing.

As a part of The University of North Carolina, UNC-TV receives continuing support through UNC from the NC General Assembly and diminishing federal support through PBS. Member support now provides UNC-TV with approximately one-third of its annual budget. Children's series with STEM content include: *Biz Kids*, *Curious George*, *Curiosity Quest*, *Cyberchase*, *Design Squad*, *Dinosaur Train*, *Dragonfly TV*, *Enviropals*, *Sesame Street*, *Sid the Science Kid*, and *Wild Kratts*. General audience science/STEM series include: *Carolina Outdoor Journal*, *Explore North Carolna*, *The History of Science*, *Life on Fire*, *Nature*, *NOVA*, *novaSCIENCEnow*, *Quest*, and *Saving the Bay*.

Indicator 3: Quality and speed of Internet access

Metric (2011-12): *Percent of households with Internet Broadband access (2010):* **NC: 65.10%** *(NC: 38th in the U.S.; 5th in South after FL, VA, GA, TX.);* **US: 67.94%**

Metric (2011-12): *Average Internet download speed (mbp index, with higher numbers indicating faster speeds):* **NC: 14.17mbps** *(ranked 32 in the U.S.);* **US: 15.81mbps** *(ranked 34 globally)*[79]

Metric: *(NC ranks 32nd in the US; 8th in South after VA, FL, TN, AL, GA, SC, and LA. Results were obtained by analyzing test data between Jan. 13, 2013 and Feb 11, 2013 by NET INDEX.)* [80]

Metric (2010): *The percent of households below minimum of FCC 2015 goal of 50 mbps download and 20 mbps upload:* **NC: 57%** *(36th in the US; 9th in the South after VA, FL, TN, GA, AL, SC, LA, TX);* **US: 49%** *(34th globally)*[81]

UNC-TV is the second most-used state-supported service in North Carolina after the road system. Many of the programs are STEM-related, including stalwarts like *Nature* and *Nova*.

[78] www.unctv.org/content/about.
[79] National Telecommunications & Informational Administration, U.S. Department of Commerce, www.ntia.doc.gov/data/CPS2010_Tables, www.ntia.doc.gov/files/ntia/publications/esa_ntia_us_broadband_adoption_report_11082010_1.pdf.
[80] NET Index: www.netindex.com/download/2,1/United-States.
[81] Speed Matters, A Report of the Communications Workers of America (2010) http://cwa.3cdn.net/299ed94e144d5adeb1_mlblqoxe9.pdf.

READY Anywhere! **is a collaborative effort striving for sustainable 24/7 access to an Internet-connected mobile device for all students attending North Carolina public schools regardless of their geographic location or economic status.**

Metric (2008-12): *The ratio of students to instructional computers with Internet access by school level and overall: Elementary:* **NC: 2.42:1**, **US: 3.2:1** *(2008); Secondary:* **NC: 1.87:1**, **US: 2.9:1** *(2008); Middle:* **NC: 2.01:1**, *US: NA; High School:* **NC: 1.74:1**, *US: NA Overall:* **NC: 2.06:1**[82]

High-speed Internet is essential for economic growth and global competitiveness. High-tech innovation, job growth, telemedicine, medical records, distance learning, rural development, public safety, a more efficient e-government and a globally competitive K-20 education all require truly high-speed, universal networks. The United States is 15th in the world in broadband adoption. As noted earlier, South Korea, Japan, Sweden and even Romania have much faster Internet connections than the United States. North Carolina is well below the South, the nation, and many international countries in broadband connectivity and speed, but significant efforts are underway which should make the state more competitive in the near future.

Governmental action—in partnership with the private sector—is essential to stimulate broadband investment and adoption. Currently, the NC Department of Commerce, MCNC, the Golden Leaf Foundation, forward-looking policymakers and the business community in NC are focused on more assertive action to expand high-speed broadband access across the state. MCNC and its partners have been recognized for the efficiency in which they have implemented BTOP Golden Leaf Rural Broadband Initiative funding which will add 2598.53 miles of newly operational network infrastructure. *(See www.mcnc.org/btop/progress/map)*

The READY Anywhere! initiative is a collaborative effort of interested local education agencies (LEAs) and charters, the North Carolina Department of Public Instruction, and NC Broadband, a division of the North Carolina Department of Commerce, to strive for sustainable 24/7 access to an Internet-connected mobile device for all students attending North Carolina public schools regardless of their geographic location or economic status. *(See www.ncpublicschools.org/docs/connectivity/ready-intro.pdf.)* These, along with many other grassroots efforts, have the potential to make a significant difference.

While virtually all demographic groups in the U.S. have increased adoption of broadband Internet at home from year to year, disparities among demographic groups remain, with blacks, Hispanics and the poor showing the least access in the home. *(Note: Studies of the use of the Internet in homes with access to the Internet also show demographic disparities as well.)*

Access to high-speed Internet is related to the availability of instructional computers for students to use in schools beyond those that may be available in computer labs, but distributed more widely throughout the school for ready access during instruction. Fortunately, the student-to-computer ratio in the public schools of North Carolina is at or better than the national average from elementary through high school.

The North Carolina School Connectivity Initiative has brought first-rate scalable Internet access, including Web security and content filtering, to the school building. However, related to the availability of wired high-speed Internet is the

[82] http://nces.ed.gov/programs/digest/d11/tables/dt11_109.asp?referrer=report and e-mail communications December 19, 2012 & February 1, 2013, with John Hardin, Executive Director, Office of Science & Technology, North Carolina Department of Commerce; February 1, 2013, with Deborah Watts, Research Director, NC Broadband; February 13, 2013, with Mary Ann Wolf, CEO, Wolf Ed; February 14, 2013, with Angela Bailey, Director, NC Broadband, a Division of the NC Department of Commerce; February 14. 16, 2013 with Neill Kimrey, Director of Instructional Technology at the North Carolina Department of Public Instruction.

availability of high-density wireless and instructional computers in our K-12 public schools, including charter schools. The federal Race to the Top grant awarded to North Carolina helped public schools move towards high-density enterprise-class wireless, but millions more dollars are needed to ensure it becomes the standard. While recent national comparisons are elusive, especially with *Bring Your Own Device* initiatives, the student-to-computer ratio in the public schools of North Carolina appears to be at or better than the national average from elementary through high school. Nevertheless, to compete globally, North Carolina must continue to strive for a 1:1 student-to-computer ratio that leverages the educational benefits of mobility.

Indicator 4: Impact and productivity of MCNC[83]

Metric (2011-12): *Connectivity speeds for school districts increased by 10-30 times the speeds available in 2008.*

Metric: (2011-12): *Implementation of a fiber optic Internet "backbone" to create the North Carolina Research and Educational Network (NCREN)*

Metric: *Cost savings to NC from single source broadband purchase to serve NCREN with no broadband metering for in-state traffic approximately $12-12.5 million a year.*

Metric: *Geographical impact of the Golden Leaf Broadband Initiative*

This 69-county service area includes:

* **32,597 square miles** (67% of NC's total square mileage)
* **5.93 million** total population (66% of NC's population)
* **2.32 million** households (66% of NC's households)
* **160,000** businesses (68% of NC's businesses)
* **4,066** community anchor institutions (68% of NC's CAIs)
* Approximately **709,500 households** without access to broadband (31%)

MCNC is an independent, non-profit corporation that operates the North Carolina Research and Education Network (NCREN). NCREN connects all K-12 schools, community colleges, all public universities and most private colleges and universities, and a growing number of non-profit hospitals and public health agencies (collectively called Community Anchor Institutions) throughout the state to each other, the Internet, and global research networks at very high speeds. Through the provision of value-added services, tools and its operation of NCREN, MCNC helps improve teaching, learning, research, health care, and collaboration throughout North Carolina in a cost-effective environment for constituents. Access to broadband and fiber-optic infrastructure is essential for innovation and economic development everywhere in North Carolina. MCNC enhances the state's competitive position in the world by providing high-speed access to Community Anchor Institutions throughout North Carolina while also offering fiber assets to the private sector to help meet the broadband demands every citizen needs to succeed in the 21st century.

MCNC is an independent, non-profit corporation that operates the North Carolina Research and Education Network—a fiber-optic Internet "backbone" that connects all K-12 schools, community colleges, all public universities and most private colleges and universities, and a growing number of non-profit hospitals and public health agencies across the state.

[83] February 15, 2013 email exchange from Joe Freddoso, President and CEO, MCNC; www.mcnc.org.

$144 million

MCNC completed a $144 million expansion of the North Carolina Research and Education Network in 2013.

Wireless 4G, WiFi mesh, and White space are all wireless technologies that will change the face of the rural last mile over the next three to five years. Wireless "last mile" traffic has to find fiber infrastructure as quickly as possible to get to the Internet. A key piece of the Internet delivery ecosystem is now controlled by MCNC. No other state in country has such an agency.

MCNC completed a $144 million expansion of the North Carolina Research and Education Network (NCREN), in 2013. This initiative has been labeled the Golden LEAF Rural Broadband Initiative. To fund this expansion, MCNC applied for and received two U.S. Department of Commerce Broadband Technology Opportunities Program (BTOP) awards totaling $104 million. In addition, MCNC raised $40 million in private matching funds as required by the BTOP program. MCNC's sources of matching funds included $24 million from the Golden LEAF Foundation, $8 million from the MCNC Endowment, $4 million from private-sector wholesale telecommunications company FRC, and an estimated $4 million through donations of land and existing conduit from individual community colleges, universities, and others including the Albemarle Pamlico Economic Development Corporation. No direct funding from the state of North Carolina was required. MCNC estimates the expansion of NCREN will create or save 2,500 engineering, construction, and manufacturing jobs in the state.

Indicator 5: Quality and productivity of the North Carolina School of Science and Mathematics (NCSSM)[84]

Metric (2011-12): Quality

* In 2012, NCSSM ranked 29th in the top 1,000 public high schools in the United States by *Newsweek*—and in the top 100 for 14 consecutive years. In 2011-12 NCSSM was rated number 25 in top 100 high schools in the U.S.
* **The students:** NCSSM students have consistently performed extremely well in national academic competitions, and NCSSM's SAT scores are among the highest in the state of North Carolina. The Class of 2011 had a mean SAT score of 1361 (verbal and math). In the 2010-2011 academic year, 96 percent of students received a 3 or higher on Advanced Placement examinations.
* **Student competitions:** NCSSM has had nine national finalists and six national winners in the Siemens Competition in Math, Science and Technology since the competition began in 1999, achievements which are the most of any school in the nation. In 2011, an NCSSM team won the Conrad Foundation's Innovation Summit grand prize and boasted two national finalist teams. In 2011, NCSSM won the third annual Singapore International Mathematics Challenge, a competition that provides students with the opportunity to be innovative, creative and to develop a global mindset in the pursuit of knowledge. In 2010, NCSSM won the National Science Bowl national high school competition sponsored by the U.S. Department of Energy. The NCSSM faculty has won four Presidential Awards for Excellence

[84] www.ncssm.edu and e-mail communications with Aaron Plourde, October 30, 2012 and Melissa Thibault, December 10, 2012.

in Mathematics and Science Teaching, the highest honor bestowed by the United States government for K-12 mathematics and science teaching.

* **The faculty:** 100% of faculty members hold a master's degree; 35% hold a doctorate; 25% are National Board Certified Teachers

Metric (2011-12): Productivity

* Students: 680 resident students
* 1,586 students enrolled in distance education
* 8,200+ students participating in outreach programs
* Teachers: approximately 3,000 teachers participated in resident, off campus and on-line professional development programs offered by NCSSM

NCSSM is a two-year, public residential high school located in Durham that focuses on the intensive study of science, mathematics and technology. It was the first public residential high school established for STEM education in the United States. The school accepts rising juniors from across North Carolina and enrolls them through senior year. Though NCSSM is a public school, enrollment is limited, and applicants undergo a highly competitive review process prior to admission. But, while it has a sizable resident population, it extends its program to a significant number of non-resident students across the state. The NCSSM is also a respected provider of high-quality professional development for STEM teachers throughout the state. NCSSM is a founding member of the National Consortium for Specialized Secondary Schools of Mathematics, Science and Technology (NCSSSMST) and a constituent institution of the University of North Carolina system.

Indicator 6: Productivity and impact of North Carolina New Schools

Metric (2009-10): STEM school student performance for schools designated as New Schools:[85]

* 20 percentage point gain on passing rates for all state End-of-Course exams vs. the state's overall 8.8 point gain
* 27.2 point gain in Algebra II passing rate vs. 12.4% for the state
* 21.9 point gain in Biology vs. 9.7 points for the state
* 31% of students took Algebra II compared to 18% of all high school students statewide

Metric (2011-12): Retention and Dropouts:

* 42 of the 99 NC New Schools partner schools lost no students to dropping out
* 77 of the partner schools lost no more than two students as dropouts
* 79 partner schools lost no students from 9th grade
* The 99 partner schools had a combined dropout rate of 1.4%, compared to 3.01% for the state as a whole
* The 74 partner early colleges had a combined dropout rate of only 0.5%

The North Carolina New Schools initiative started with a grant from the Gates Foundation to develop a network of re-invented high schools, from the large comprehensive high school model to smaller, more focused high schools with specific missions and purposes. Now, eight years after its launch, over 100 schools are operating or in progress to operational status in this network, as the following map indicates.

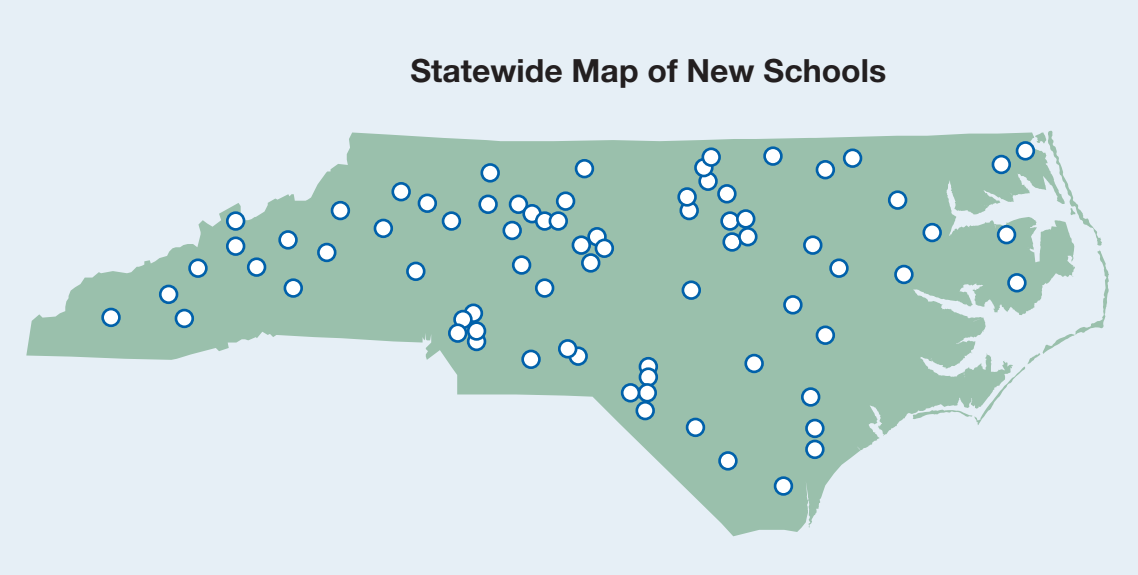
NCSSM

One of the state's most innovative and recognizable investments lies in its commitment and support to the North Carolina School for Science and Mathematics—the first residential high school in the country devoted to STEM learning.

[85] www.ncnsp.org.

New Schools

North Carolina New Schools achieved a 20 percentage point gain on passing rates for all state End-of-Course exams vs. the state's overall 8.8 point gain in 2009-10.



Within partner districts, North Carolina New Schools works to tailor different models to meet different needs. More than 25,000 students statewide now attend one of these types of schools:

Large middle and high schools are reimagining existing structures and approaches to meet the individual needs of each student.

Career academies and small learning communities are created as schools-within-schools that embrace many of the same effective strategies that characterize the state's innovative schools: rigor and opportunity for all; theme focus; strong collaboration.

Regional schools capitalize on the shared strength of partnerships to provide students with an option for career-focused education.

STEM-focused schools are forging meaningful connections between classroom learning and real-life experience in the workplace, from hospitals to research laboratories, and preparing students with skills to design and communicate solutions to real problems with confidence and ingenuity.

District-wide transformation aims to apply the lessons of successful innovative schools so that all students in all schools benefit and so all students graduate with postsecondary education as an option.

Early college high schools give students the chance to earn an associate degree or two years of college credit—tuition free—along with their high school diploma.

Since 2007, North Carolina New Schools has helped create more than 100 STEM-themed high schools in North Carolina, in addition to providing STEM-focused curriculum and training to other North Carolina New Schools-inspired schools throughout the state. NC New Schools also works to establish secondary schools that immerse students in the STEM disciplines while following the same course of study required of all NC high schools. These schools infuse the

guiding principles of many STEM fields—a spirit of inquiry, real-world project-based inquiry, design and analytical thinking—across the curriculum at all North Carolina New Schools-affiliated schools.

STEM schools created in partnership with North Carolina New Schools have school environments focused on a variety of academic themes. Schools developed around the same theme, or "affinity," are grouped together in a network, with each network having an anchor school that serves as a model and central communications hub across the network. The four affinity networks are focused on:

* Aerospace, Advanced Manufacturing & Security
* Biotechnology & Agriscience
* Energy & Sustainability
* Health & Life Sciences

Indicator 7: Productivity and impact of The Science House at NCSU[86]

Metric (2007-10): Students: *Science House programs reached over 30,000 students annually in the period from 2007-2010.*

Metric (2007-10): K-12 educators: *Science House professional development programs involved 5,000 teachers and approximately 1,000 administrators annually in the period from 2007-2010.*

Established by North Carolina State University's College of Physical and Mathematical Sciences in 1991, The Science House exists to: (1) cultivate and inspire K-12 students, especially those from underrepresented groups, through innovative programs to study and work in STEM fields, and (2) educate and empower K-12 STEM teachers to effectively integrate innovative STEM content, research, and technologies into their practices. The Science House is based at NC State's Centennial Campus and has five regional outreach offices across the state. The Science House mission is to work in partnership with K-12 teachers and students to promote the use and impact of hands-on inquiry based learning in science, technology, engineering and mathematics.

Indicator 8: Productivity and impact of the Summer Ventures in Science and Mathematics (SVSM) program[87]

Metric: 335 students from 57 counties were enrolled in Summer Ventures in 2012. *From summer 1985 to summer 2009 the program served well over 12,000 high school students—with participants from every county in North Carolina. The average GPA for participants over the history of the program is 3.55 on a 4.0 scale. The demographic makeup of participants is 60% female and 40% male, 71% Caucasian, 12.7% African-America, 12.8% Asians, 1.4% Hispanic and less than 1% Native American. Many more qualified students apply than can be accepted. Of students six years or more years out of high school, 65% have college degrees in a STEM field, 56% are pursuing STEM careers, 55% have achieved graduate degrees and 24% are teaching or plan to teach in a STEM field. More than 74% attend (or attended) a UNC institution.*

Summer Ventures in Science and Mathematics was created by the North Carolina General Assembly in 1984 as a cost free enrichment program for academically motivated high school students potentially interested in a career in science or mathematics. The North Carolina School of Science and Mathematics coordinates SVSM. Initially more expansive, currently this program is located on four campuses of the

Science House

Based at NC State's Centennial Campus, the Science House's mission is to work in partnership with K-12 teachers and students to promote the use and impact of hands-on inquiry-based STEM learning.

[86] www.science-house.org and February 19, 2013 e-mail from Jason Painter, Director, The Science House.
[87] www.summerventures.orgSVSM_25thAnniv_booklet.pdf, (Printed NCSSM Publications March 2011).

65%
In 2012, 1,771 students were enrolled in the NC Pre-College program, with 65% reporting that they planned to pursue a STEM major.

University of North Carolina System: Appalachian State University (ASU), East Carolina University (ECU), North Carolina Central University (NCCU), and University of North Carolina at Charlotte (UNCC). This pioneering program is still a one-of-a-kind opportunity in the United States.

Indicator 9: Productivity and impact of the NC-MSEN Pre-College program[88]

Metric (2011-12): Productivity: *1,771 students were enrolled in the Pre-College program in 2012. An estimated total of 40,916 students enrolled in the NC-MSEN Pre-College Program from 1986 to 2012.*

Impact: *The 2012 Annual Survey of Pre-College high school seniors yielded the following results (which were findings similar to previous years): 96% of the Pre-College Program high school seniors reported that they planned to pursue postsecondary education; 2% planned to join the Armed Forces; 79% reported they were accepted to attend colleges or universities in North Carolina; 65% reported they planned to pursue a STEM major, 5% to pursue a teaching major, and the remaining planned to pursue business, law, art, or other professions; 68% reported they planned to pursue advanced degrees. In 2011, over 54% reported that they had been offered some form of scholarship OR multiple scholarships, totalling $2,382.867.* The NC-MSEN Pre-College Program was created by the NC General Assembly in 1986 with a mission to increase the pool of students who graduate from North Carolina high schools with sufficient interest and preparation to pursue university-level majors that lead to careers in science, technology, engineering, mathematics, and teaching. The program has a special focus on attracting underrepresented minorities and females. Parental engagement is a central feature of the program. Students enter the multi-year academic program as rising 6th graders and are expected to re-enroll until they graduate from high school. Though recent budget cuts have reduced the number of programs, universities still hosting Pre-College programs are well distributed across NC, including: Elizabeth City State University, Fayetteville State University, NC State University, UNC-Chapel Hill, and Winston-Salem State University.

Indicator 10: Productivity and impact of teachers participating in STEM programs offered by the North Carolina Center for the Advancement of Teaching (NCCAT)[89]

Metric (2011-12): Productivity: *While NCCAT serves many more teachers per year, 291 teachers across NC received about 30 contact hours per teacher of STEM-specific professional development in 2011-2012.*

Impact: *Evaluations of the success of each seminar according to 13 different measurements ranging from intellectual rigor to likely impact on student achievement. The average rating on a five-point Likert Scale was 4.9.*

The NC General Assembly passed legislation in 1985 to establish the North Carolina Center for the Advancement of Teaching (NCCAT). The Assembly recognized that great teaching is essential to high-quality education. Since it was founded, this nationally acclaimed center has

[88] www.unc.edu/depts/msen.
[89] www.nccat.org/s/1099/start.aspx and e-mail communication with Dr. Elaine Franklin, NCCAT Executive Director, November 28, 2012 elaine.franklin@nccat.org.

served more than 67,000 teachers and other educators who have consistently rated their NCCAT program as one of the most significant professional learning experiences of their career. NCCAT operates two campuses, the main campus in Cullowhee and the eastern campus on Ocracoke Island. STEM-specific programs for teachers were held in 2011 at both NCCAT sites, covering topics such as financial literacy, forensic science, coastal geology, technology, and health sciences. A special focus was placed on the integration of STEM topics with literacy instruction and on the integration of Common Core State Standards into the teaching of STEM subjects

Indicator 11: Productivity and impact of the Kenan Fellows Program (KFP)[90]

Metric (2011-12): *120 teachers, plus faculty and industry mentors have benefitted from the KFP since the beginning in 2000. The number of applications for 2012 was triple the number of fellowships available, with 66 fellowships awarded from 217 applications. The class of 2012 was the largest to date and included 19 Fellows who were selected to work with the NC Department of Public Instruction to support the implementation of the Common Core and Essential Standards.*

Impact on Students: *A total of 675 students (348 or 51.6% female and 289 or 42.8% male) responded to a 2011-12 survey on their experience working with a Kenan Fellow math or science teacher. Almost three-quarters of respondents agreed or strongly agreed that they know more about how math and science is used in the real world at the end of the school year compared to when they started the school year. Additionally, 70% reported that their teacher made them feel more positive about math and science this year and 60% of students reported being more positive about math and/or science in general.*

Impact on Teachers: *Of the 85 of 120 alumni responding to a short survey in 2011, 64 or 75% of Kenan Fellows are still classroom teachers, and another 15 continue to work in education as school administrators, district administrators, or in other positions (e.g., counselor, media specialist, etc.). A total of 93 percent of survey respondents remain active in education. In 2012-13, only two Fellows had plans to leave education, with the majority (91%) continuing as classroom teachers and four serving in administrative roles.*

The Kenan Institute for Engineering, Technology & Science at NC State University established the Kenan Fellows Program for Curriculum and Leadership Development in 2000. Outstanding K-12 public school teachers nominated and selected as Kenan Fellows engage in a year-long fellowship in partnership with university researchers and industry experts. Key components of the fellowships are a five-week summer research experience supported by two weeks of professional development. Teachers transfer relevant information from this experience back to the classroom. Fellows create and disseminate innovate curriculum materials via online lesson banks and professional development workshops for other educators.

93%

An estimated 93% of Kenan Fellows, a program established by the Kenan Institute for Engineering, Technology & Science at NC State University, remain active in education.

[90] http://kenanfellows.org.

$48 million

Burroughs Wellcome Fund's comprehensive agenda has contributed over $48.2 million to advance STEM education in North Carolina. One program alone, the Student Science Enrichment Program, has reached 37,000 students across the state.

Indicator 12: Productivity of grants and programs from the Burroughs Wellcome Fund (BWF)[91]

Metric (1996-12): BWF's comprehensive agenda has contributed over $48.2 million to advance STEM education in NC through its many programs for teachers and administrators. *One program alone, the Student Science Enrichment Program, has reached 37,000 students in NC. Students and teachers in all 100 counties of NC have benefitted from BWF support and programs. BWF has identified excellent STEM teachers and committed to building their careers and advancing learning in schools and districts across North Carolina. This statewide program has reached teachers and students in Alleghany, Buncombe, Charlotte/Mecklenburg, Cumberland, Gaston, Guilford, Haywood, Pitt, Transylvania, Warren, and Winston-Salem Forsyth counties. A focus on elementary mathematics called the Singapore Mathematics Pilot has targeted seven elementary schools across the state. This training program for teachers emphasizes strong number sense, excellent mental-math skills, and a deep understanding of place value to help students with mathematics.*

The Burroughs Wellcome Fund (BWF) has invested in the STEM arena since 1996 to help build systemic reform in science, technology, engineering, and mathematics education primarily in North Carolina, focusing on the following areas:

* Informal Learning
* Formal Learning
* Public Policy and Research
* Capacity/Partnership Building

An example of BWF's support of STEM teacher productivity is the FastTrack-University Program to Prepare Science and Mathematics Teachers. BWF has invested $5.4 million in the University of North Carolina General Administration to produce 120 K-12 teachers with degrees in the sciences or mathematics through the FastTrack Program. Students receive scholarships in their junior and senior years toward the goal of graduating with teaching certification within a four-year timeframe. Upon graduation, FastTrack provides $5,000 salary supplements for five years once teachers enter the workforce. FastTrack now has over 38 teachers in the classroom and over 24 scholars in junior and senior years gearing up to teach in North Carolina public schools.

In 1996, BWF partnered with the NC Public School Forum and the Kenan Trust to create the North Carolina Institute for Education Policymakers. In 2011, the institute conducted a study of the Finland school system—one the highest achieving systems in the world. Seven members of the General Assembly, two members of the State Board of Education, five members of the UNC system and 17 others participated on this study.

Although the majority of the BWF work in science education is done in its home state of North Carolina, BWF is engaged with national organizations including the National Research Council, the Smithsonian Science Education Center, and the American Association for the Advancement of Sciences to broaden knowledge and to bring best practices to North Carolina.

[91] www.bwfund.org and e-mail correspondence with Carr Thompson, January 15, 2013. cthompson@bwfund.org.

Indicator 13: Productivity of grants provided by the Golden Leaf Foundation[92]

Metric (2011-12): General: *The Golden Leaf Foundation Board, since its inception in 1999, has awarded 1,152 grants across a wide range of initiatives worth over $508 million.*

STEM Initiative: *In response to a STEM educational gap analysis by The Sanford School of Public Policy at Duke University, the Foundation initiated a competitive $5 million grant program to establish proven curricular programs in STEM education that are based on project- and inquiry-based instructional practices, expose students to regional careers and link middle school education to advanced training in higher education to prepare all students to be college- and career-ready. Golden LEAF awarded $5,386,592 million to support 15 projects in 46 school districts. This three-year initiative has established comprehensive programs in STEM education targeting teacher effectiveness and preparing students for success in math and science and other core academic classes that are essential to college and career readiness.*

Essential Skills in Advanced Manufacturing Workforce Training Initiative: *In the 2012-13 grant cycle, the foundation Board awarded 14 grants totaling $7,391,225 to assist 22 community colleges to enhance existing training capabilities and deliver hands-on training in skill areas that are in demand by North Carolina companies. These projects will serve 32 counties across the state and target more than 5,134 employment opportunities identified by industry over a two to three-year period.*

The Golden LEAF Foundation is a nonprofit organization established in 1999 to help transform North Carolina's economy. The foundation receives one-half of North Carolina's funds from the 1998 Master Settlement Agreement with cigarette manufacturers and places special emphasis on assisting tobacco-dependent, economically distressed and/or rural communities across the state. The Golden LEAF Foundation works in partnership with governmental entities, educational institutions, economic development organizations and nonprofits to achieve its mission.

The Golden LEAF Board of Directors has initiated two special initiatives in the past two years intended to address some of the urgent workforce requirements North Carolina faces in transitioning to a 21st century economy and preparing all students to be college- and career-ready upon graduation. These workforce initiatives were strategically designed to address gaps in training in rural, economically disadvantaged and/or tobacco dependent counties by establishing career pathways that expose middle schools students to STEM education and career opportunities that require science, mathematics, technology and engineering skills for employment with workforce training programs in higher education that align with the state's transitioning economy.

$5.3 million

In response to a STEM educational gap analysis by The Sanford School of Public Policy at Duke University, Golden LEAF has awarded $5,386,592 million in grants to support 15 projects in 46 school districts in North Carolina.

[92] www.goldenleaf.org and January 17 and February 20, 2013 e-mail communications with Mark Sorrells, Senior Vice President, The Golden Leaf Foundation.

175,000

The North Carolina Virtual Public School has served over 175,000 middle and high school students since its initial launch in the summer of 2007.

Indicator 14: Productivity and Impact of NC Virtual Public School (NCVPS)

Metric: *147 students enrolled in three STEM courses, including four students repeating a course for credit.*

Metric: *67% in an end-of-course STEM exam were proficient.*

The North Carolina Virtual Public School is a supplemental service to the public schools of North Carolina. Students enroll through their local public school; grades are reported to their public school, which awards credit. The courses use learning management and collaborative software to maximize student interaction in each class. NCVPS teachers use the latest technologies to engage students as well as prepare them to be college- and career-ready. The North Carolina Virtual Public School has served over 175,000 middle and high school students since its initial launch in the summer of 2007.

NCVPS Virtual STEM Project is a project-based blended mobile and non-mobile learning environment. Courses are designed around selected Grand Challenges from the National Academy of Engineers. A goal of the project is to encourage teachers to explore and create content that is relevant and extends the curriculum beyond the classroom. The use of a mobile device is geared towards students and teachers creating inquiry-driven products. Merging this practice with project-based learning creates a facilitative role for the teachers and develops students' ability to be collaborative and conduct research. Virtual STEM presents the opportunity to connect students and teachers across the state to solve problems that are relevant now. The connection of 21st century skills and 21st century technology makes STEM relevant for the digitally proficient.

Domain Summary

Several key insights can be taken from this analysis of Strategic Innovations and Investments, including the following:

1. These innovations, like most of North Carolina's efforts to connect STEM learning to both individual benefit *and* economic benefit, represent substantive investments. Each initiative is working to accomplish its mission and goals toward expanding both educational access and opportunity and economic development in North Carolina. individually each program is impressive; taken together, this collection of STEM innovations places North Carolina high on the list of states seeking to create a distinct and operational connection between education and the economy.

2. All of these innovations have a great deal to offer the state of North Carolina in its efforts to strengthen the STEM education pipeline. While every program may not be widely known, together they provide a statewide network of rigorous STEM instruction, professional development and technical support.
3. There is no real evidence that leaders of these innovative organizations communicate well with one another, or any other STEM-related organization. In these busy and complex times, leaders of these organizations have plates full of responsibilities, but no single entity that we have presented for analysis in this STEM ScoreCard holds a monopoly on STEM impact. Senge (1990)[93] tells us of the importance of 21st Century institutions becoming "learning organizations." Fullen (2007)[94] describes "knowledge creation and sharing" as a fundamental requirement for organizational effectiveness. To get to where North Carolina needs and wants to be economically by the end of this decade, silo mentalities do not serve those needs very well.

Action Items

1. **NCSSM, The Science House, Kenan Fellows, NCCAT, Summer Ventures, NC-MSEN Pre-College programs, and informal education providers should seek ways to collaborate and collectively expand their reach to more teachers and students across the state.**
2. **North Carolina corporations and foundations should promote and support an initiative to increase afterschool and summer learning opportunities for children from under-represented minority populations and children from low-income families.**
3. **MCNC and NC Broadband should be supported through public-private partnerships to aggressively expand high-speed broadband Internet access for every community and household across North Carolina.**

The benefits the state derives from these STEM programs are substantial, and they compel consideration of public funding and support from the general assembly to replicate or expand many of these efforts. The current state of affairs in North Carolina will not lead to a STEM-literate citzenry and the robust state economy described in the first domain.

NCVPS Virtual STEM Project is a project-based blended mobile and non-mobile learning environment. Courses are designed around Grand Challenges from the National Academy of Engineers. The project's goal is to encourage teachers to explore and create relevant content that extends the curriculum beyond the classroom.

[93] Senge, P. (1990). The fifth discipline: The art and practice of the learning organization. Crown: Cambridge, MA.
[94] Fullen, M. (2007). Leading in a culture of change. Jossey-Bass: San Francisco, CA.

DOMAIN FOUR:

College and Career Readiness

The goal: Ensure that all students excel in a rigorous core curriculum that reflects the skills and knowledge they'll need in the new STEM-based economy.

Thus far in the ScoreCard, we have attempted to establish a clear picture of the requirements needed for North Carolina to qualify, acquire, and succeed in identifying and filling a multitude of STEM jobs for the future—the key drivers of North Carolina's economic engine. We then established a picture of how well North Carolina provides opportunities for STEM engagement and literacy, both to attract young people into further STEM learning, and also to provide adult support for STEM policy and initiatives. We presented insights into a number of STEM-related investments North Carolina provides that build additional support for and the development of STEM excellence. The next section of the ScoreCard presents an analysis of how well North Carolina is educating, supporting, developing, and sustaining K-20 students in their respective passages through and exit from the STEM pipeline into the jobs of the future.

The overwhelming majority of all STEM jobs will require knowledge and skills best obtained through K-12 and postsecondary studies. **The key question is: How does North Carolina know how well prepared its children are to begin and successfully navigate their journey through the STEM pipeline so that they are ready to compete for and succeed in STEM occupations?**

We organize the analysis along several well-defined breaking points. The first section examines student achievement in North Carolina's public K-12 schools, with particular attention to the continuing achievement gaps among various segments of our student population and the economic consequences of allowing those gaps to continue unchallenged. This is followed by an analysis of postsecondary readiness for STEM studies, and an assessment and analysis of how well North Carolina is preparing and graduating young adults for the many STEM jobs we have advocated. The table on the next page shows composite scores across grade levels, not individual grade-level composites reported in the indicators. This section also examines achievement measures on the math and science tests administered by the National Assessment of Education Progress (NAEP), often described as the nation's report card.

The majority of STEM jobs will require substantial acquisition of knowledge and skills best obtained through K-12 and postsecondary studies. How well prepared are North Carolina children to enter into and successfully navigate the STEM pipeline?

K-12 students in North Carolina perform reasonably well on the state assessment in math and science. However, these same students record lower scores on NAEP tests.

Indicator 1: Percentage of students deemed proficient on math EOG (End of Grade exams) (grades 3-8)

Metrics (2011-12): *Grade 3:* **84.0%**; *Grade 4:* **86.7%**; *Grade 5:* **83.3%**; *Grade 6:* **81.2%**; *Grade 7:* **81.2%**; *Grade 8:* **85.9%**[95]

Indicator 2: Percentage of high school students proficient in Algebra I EOC (End of Course exams)

Metric (2011-12): **78.7%**[96]

Indicator 3: Percentage of 5th graders proficient on science EOC exams

Metric (2011-12): **77.0%**[97]

Indicator 4: Percentage of 8th graders proficient on science EOG exams

Metric (2011-12): **78.1%**[98]

Indicator 5: Percentage of students proficient on Biology EOC exams

Metric (2011-12): **83.0%**[99]

Indicator 6: Percentage of students enrolled who pass Integrated Math III

Metric (2011-12): **89.4%**[100]

Indicator 7: Percentage of students enrolled who pass Algebra II

Metric (2011-12): **87.1%**[101]

When NC's K-12 students are assessed on math and science achievement using state assessments, they do fairly well. In every instance, achievement measures indicate that at least 75 percent or more of our students tested in EOGs and EOCs met or exceeded the state's definition of proficiency or achieving at grade level.[102]

Summary of Composite Scores in STEM Subjects

(Percentage at or above grade level – level 3)

Subjects	NC	Notes
Mathematics EOG (Grades 3-8)	**82.8%**	2011-12 data
Science EOG (Grades 5 and 8)	**76.8%**	Only grades tested in science 2011-12
Algebra I EOC	**78.7%**	Only math test required for graduation
Biology EOC	**83.0%**	Only science test required for graduation
Algebra II	**78.7%**	Passing rate, not EOG score
Integrated Math III	**83.0%**	Passing rate, not EOG score

Source: NC DPI (Testing and Accountability Services)

North Carolina's performance measures were examined on the math and sciences tests administered by NAEP. These tests are given to 4th and 8th graders across the country, thereby providing benchmark comparisons with other states and the U.S. The next three indicators (8-10) provide the results.

Indicator 8: Percentage of students proficient or better on the National Assessment of Educational Progress (NAEP) science assessment of students in grade 8

Metric (2011-12): *Grade 8:* **NC: 26.0%**; **US: 31.0%**[103]

Indicator 9: Percentage of students proficient or better on the National Assessment of Educational Progress (NAEP) mathematics assessment of students in grade 4

Metric (2011-12): *Grade 4:* **NC: 45.0%**; **US: 39.0%**[104]

95-101 NC DPI (Testing and Accountability Services) http://accrpt.ncpublicschools.org/app/2012/disag.
102 Grade-level proficiency was defined as achieving a Level III (out of IV) scale score or higher. This set of accountability measures will be replaced by new assessments based on the Common Core and Essential Standards for 2012-13.
103-105 National Center for Educational Statistics – http://nces.ed.gov/nationsreportcard/subjectareas.asp.

Summary of NAEP Scores in STEM Subjects
(Percentage proficient or better)

Subjects	NC	National Average
Science (Grades 8)	**26.0%**	31.0%
Mathematics (Grades 4)	**45.0%**	39.0%
Mathematics (Grades 8)	**37.0%**	34.9%

Source: National Center for Educational Statistics

Indicator 10: Percentage of students proficient or better on the National Assessment of Educational Progress (NAEP) mathematics assessment of students in grade 8

Metric (2011-12): *Grade 8:* **NC: 37.0%**; **US: 34.0%**[105]

There appears to be a disconnect between state assessments and national assessments in mathematics and science. The NAEP metrics are lower than those reported for EOC scores: NAEP achievement in mathematics by NC students is around half of the achievement on EOGs and EOCs. NAEP science scores indicate that only slightly over a quarter of 8th graders are proficient or better in science. Because NAEP is a national assessment, the definition of what constitutes proficiency has to encompass national differences. Therefore, NAEP is regarded as a more stringent standard for proficiency than is typically found in state assessments, including North Carolina's. Nevertheless, the NAEP metrics do reveal some good news. First, North Carolina's NAEP scores are improving over prior assessments. Second, both of North Carolina's mathematics NAEP percentages are better than the national average. It is worth noting that the

Project Lead the Way

Authentic STEM Learning

Project Lead the Way (PLTW) in NC is part of a national not-for-profit organization that promotes pre-engineering knowledge and principles for middle and high school students. The program offers three general curricula to middle and high school students:

* Gateway to Technology (Middle Schools)
* Pathway to Engineering
* Biomedical Sciences.

Gateway to Technology, designed for middle school students, consists of two series of 10-week stand-alone units. The basic course focuses on (a) Design and Modeling; (b) Automation and Robotics; and, (c) Energy and the Environment. The advanced course consists of units in (a) The Magic of Electrons; (b) The Science of Technology; and, (c) Flight and Space.

In high schools, many PLTW programs are conducted in partnership with enterprises from the private sector. Not only do PLTW students take courses in the standard curriculum to meet graduation requirements, they take additional courses in (a) Principles of Engineering; (b) Introduction to Engineering Design; (c) Digital Electronics; (d) Engineering Design and Development; and, (e) Computer Integrated Manufacturing. Currently, PLTW programs have reached over 14,500 middle and high school students in North Carolina. The PLTW network includes 193 trained teachers, 97 counselors, and 100 North Carolina schools.

804,850
The number of students in North Carolina that are enrolled in Career and Technical Education programs with clear connections to STEM-related knowledge and work experience is 804,850.

Southern region as a whole does not perform well on NAEP. Mississippi, Louisiana and Alabama had lower science scores than North Carolina, and even Kentucky, the highest achieving Southern state, did not reach the lowest score of the nation's top 10 states.

The role of Career and Technical Education (CTE) in developing STEM capacity for technical sector jobs is examined next. Over 100 STEM-related CTE programs are in operation, or in the final stages of planning with operations anticipated for the 2013-14 school year.

Indicator 11: Number of students enrolled in CTE programs with clear connections to STEM-related knowledge and work experience

Metric (2011-12): NC: 804,850[106]

Indicator 12: Percentage of all students who tested as proficient or better on a STEM-related CTE standardized assessment as a part of their course success

Metric (2011-12): 81.2%[107]

Indicator 13: Percentage of students enrolled in CTE programs who obtain a STEM-related industry certification credential in high school

Metric (2011-12): 45.6%[108]

Indicator 14: Number of students participating in Project Lead the Way CTE programs who are proficient in the third party assessments conducted for these programs

Metric (2011-12): 4,565[109]

Indicator 15: Percentage of high school graduates who complete a full curriculum core *and* a defined CTE program of study

Metric (2011-12): 51.7%[110]

Courses and programs in Career and Technical Education have historically been regarded as a "dumping ground," a place to assign students unwilling or unmotivated to engage the standard academic curriculum. In today's quest for people to qualify for and work in the STEM jobs of the future, CTE graduates from NC's high schools are anything but second class. In fact, legislation was introduced in the 2013 session of the NC General Assembly augmenting the qualifications a CTE graduate can earn with high school graduation (SB 14). Last year, enrollment in CTE courses with a specific STEM connection reached nearly 805,000 students. Of the enrollees, over 81% were proficient in their respective CTE standardized assessments. Over 45 percent of CTE students earned a STEM-related industry certification or credential, qualifying them for an entry-level position upon graduation. How does this translate? In 2010, unemployment for the 16-19-age cohort who graduated in CTE was 5.4 percent in NC. Non-CTE graduates of the same age cohort had an unemployment rate of 27 percent.

This next section examines the quality of transitions from high school into postsecondary studies in two ways: (1) How well do high school students perform in high school courses that teach college-level STEM content (Advanced Placement scores)?; and, (2) How well do high school students perform on college readiness tests used for admission purposes (ACT and SAT scores)?

106 NC DPI Department of Career and Technical Education – www.ncpublicschools.org/cte. (This metric contains a duplicated count of student enrollees. It is calculated from course enrollment data, and, where any given student is enrolled in more than one CTE course with a STEM focus, each time he/she appears on a course roster is counted.)

107,108 NC DPI Department of Career and Technical Education – www.ncpublicschools.org/cte.

109 NC DPI Division of Career and Technical Education – www.ncpublicschools.org/docs/cte/certification-report.pdf. Project Lead the Way (PLTW) programs are specially designed CTE program offerings in collaboration with or sponsored by one of more private organizations or enterprises. As such, most often, proficiency assessments are done by the third party sponsor and not The NC Department of Public Instruction.

Summary of Advanced Placement STEM Results – 2011-12

(Percentage of students scoring 3 or higher)

Advanced Placement Exam	NC
Biology	52.0%
Calculus AB	50.3%
Calculus BC	74.3%
Chemistry	55.3%
Computer Science	58.7%
Environmental Science	57.3%
Physics B	65.5%
Physics C (Electricity and Magnetics)	74.6%
Physics C (Mechanics)	78.3%
Statistics	59.1%

Source: Educational Testing Service – College Board

Indicator 16: Percentage of all enrollees in STEM-related AP courses that score 3 or better on their respective exams

Metric (2010-11): 57.5% [111]

Indicator 17: Percentage of students who graduate within four years of entering 9th grade

Metric (2010-11): 77.9% [112]

The next three indicators (18-20) relate to the ability of NC's seniors to gain admission to post-secondary institutions. The ACT exam has a particularly useful feature for this ScoreCard. Its sub-tests (four in all) include not only an assessment of mathematics, as does the SAT, but a science assessment as well. In addition, ACT has established "College Ready Benchmarks"— minimum scores that tend to predict the probability of earning a grade of "C" or higher in a college freshman-level course in the same subject discipline.

Indicator 18: Percentage of high school students who meet or exceed "College Ready Benchmark Scores" on the ACT Math sub-test

Metric (2011-12): NC: 56%; US: 45% [113]

The average math score for NC test takers was 22.4, compared to the national average of 21.1.

ACT STEM Benchmark Percentages

(Percentage proficient or better)

ACT Test	NC Average	Benchmark Score	National Average
Mathematics	22.4%	22%	21.1%
Science	21.4%	24%	20.9%

Source: 2011 ACT Profile Report – State

Indicator 19: Percentage of high school students who meet or exceed "College Ready Benchmark Scores" on the ACT Science sub-test

Metric (2011-12): NC: 34%; U.S: 30% [114]

The average score in science for North Carolina's students was 21.4; the average score for the U.S. was 20.9.

Indicator 20: Average score on the math portion of the SAT for 2011 college-bound students

Metric (2011-12): NC: 506; US: 514 [115]

77.9% of North Carolina's students graduate within four years of entering the 9th grade.

110 NC DPI Department of Career and Technical Education – www.ncpublicschools.org/cte.
111 Educational Testing Service – College Board – www.collegeboard.com/student/testing/ap/exgrd_sum/2011.html. This metric represents the aggregation of all test takers in 10 individual AP exams with direct STEM connections.
112 NC DPI State Report Card – www.ncreportcards.org/src/stateDetails.jsp?Page=1&pYear=2010-2011.
113,114 ACT Profile Report – State www.act.org/newsroom/data/2011/pdf/profile/NorthCarolina.pdf.
115 North Carolina Department of Public Instruction 2012 SAT Report www.ncpublicschools.org/docs/accountability/reporting/sat/2012/satreport2012.pdf.

In December of 2012, the North Carolina Department of Public Instruction introduced a new STEM Access Program for 44 North Carolina high schools. Part of a $5 million grant from Google to Donor's Choice and The College Board, the program provides increased access to STEM-related Advanced Placement courses for traditionally under-represented minority and female students.

The good news is that North Carolina's average ACT scores are above the national average, as is the percentage of students exceeding the "College Ready Benchmark" in both areas. North Carolina also leads the South in mathematics scores on the ACT, and is second in the South in science, behind Virginia.

On the other hand, NC did not reach the benchmark score of 24 that predicts college success in freshman-level science, although no state, in fact, reached the science benchmark. In mathematics, North Carolina scored 2.2 points below the highest ranking state (Massachusetts), and 1.8 points below the highest ranking state (also Massachusetts) in science. North Carolina's score in mathematics on the SAT (Indicator 20) —showing an 8-point gap compared to the national score—is cause for some concern where college admissions are considered.

A Step in the Right Direction

In December of 2012, the North Carolina Department of Public Instruction introduced a new STEM Access Program for 44 North Carolina high schools. Part of a $5 million grant from Google to Donor's Choice and The College Board, the program provides increased access to STEM-related Advanced Placement courses for traditionally under-represented minority and female students. The grant funds, typically about $2,000 to $10,000 per school, are intended as start-up funding for classroom resources, educational materials, and teacher professional development. To qualify, a school must meet several criteria, including having at least 10 students from under-represented minorities and 25 female students who demonstrate the probability of success based on PSAT and/or NMSQT(National Merit Scholarship Qualifying Test) scores. Participating high schools are located throughout the state—from the mountains to the coast. For more information, visit the NC DPI website (www.ncpublicschools.org) and click on the tabs for news.

Looking at an Old Problem Through a New (Economic) Lens

High-level STEM-based occupations are available now and the number will increase over the next decade. For many of our young citizens, these jobs can offer a productive and fulfilling life as well as bring positive and sustainable economic development to North Carolina. However, the state's future economic robustness cannot be achieved, much less sustained, when significant numbers of elementary students have little to no chance of exiting the STEM pipeline with the capacity necessary to succeed at those STEM jobs. In fact, many students do not reach the end of the pipeline: some are lost along the way, others get stuck and many exit prematurely, excluding themselves as potential candidates for STEM jobs and careers.

In North Carolina as in the rest of the country, the ethnic diversity of our citizenry is changing. And, as a number of studies have shown, a significant achievement gap exists, in NC and other states, between white students and students of color. The implications for the state's economic development and the quality of life for all citizens are dependent on the state's ability to adequately prepare all North Carolinians for jobs and careers, and particularly for the number of STEM jobs expected over the next two decades. These jobs require postsecondary education, but nearly 43 percent of our citizens earn neither an associate's or bachelor's degree, often because they are not adequately prepared for college.

Two measures that connect high school achievement with college readiness are Advanced Placement (AP) tests and the ACT College Admissions test. The table below shows AP results in STEM subjects for North Carolina students, broken down by ethnic group. (A score of 3 or higher is generally considered the minimum score for achieving college credit for this high school course.)

Summary of Selected 2011 STEM AP Results by Ethnicity in NC

(Percentage who scored 3 or higher)

Ethnicity	Calculus AB	Chemistry	Computer Science
White	54.4%	55.8%	63.1%
Black	22.2%	23.2%	10%
Hispanic	37.1%	34.4%	0%
Asian	56.6%	69.7%	100%
Am. Indian	29.8%	25%	0%
Total	**50.3%**	**55.3%**	**58.7%**

Source: Educational Testing Service – College Board

If we accept the premise that success in AP courses is a proxy for probable success in college, then sizeable numbers of our young people of all population groups, but minorities, in particular, appear to be ill equipped with the knowledge and skills for success. An additional concern among minority populations is the low participation rate in AP courses and tests (see table at right). Students who do not participate in AP courses miss the opportunity for college preparation and workforce preparedness, which has a direct impact on the state's economy. Evidence also shows that female achievement in STEM education lags that of males, even when female participation is greater.

Based on 2010 U.S. Census data, a projection of the 15-24-year-old population in North Carolina might look as follows:

North Carolina 15-24 Year-Old Population Demographics

(2010 U.S. Census Data)

Ethnicity	Number	Percentage
White	923,760	70.2%
Black	297,393	22.6%
Hispanic	117,115	8.4%
Asian	45,972	2.2%
Am. Indian	34,976	1.9%
Total	**1,315,897**	**6.9%**

Source: U.S. Census Bureau

North Carolina Participation Rates by Ethnicity on Selected STEM AP Tests

Ethnicity	Calculus AB	Chemistry	Computer Science
White	74.9%	71.0%	72.3%
Black	9.0%	.05%	.07%
Hispanic	4.0%	.03%	0%
Asian	7%	15.4%	12.1%
Am. Indian	.07%	.03%	0%

Source: Educational Testing Service – College Board

In 2018, the 15-24-year-old population group will be 23-28 years old, an age when they will, ideally, be exiting the STEM pipeline and claiming jobs. The projected 1.4 million job vacancies closely match the anticipated available labor force—if people are adequately prepared. If half of those young people—about 650,000—cannot compete, they will go somewhere else or take other types of jobs. However, there will not be enough low-skill, low-wage jobs available for those 650,000

Is North Carolina producing high school graduates who can succeed in the postsecondary studies that are essential to be employable in the vast majority of future jobs? The answer is mixed.

42%

The percentage of North Carolina's community college students who earned a grade of "C" or better in a college course following participation in remedial courses is 42%.

North Carolinians. The unemployment and underemployment of this demographic will have far-reaching and unacceptable social and economic consequences for the state. This is a reality that must be addressed by the policy community.

The next section examines how well North Carolina's high school graduates do in their academic and technical pursuits to acquire STEM competence by posing **two essential questions: (1) Is North Carolina producing high school graduates who can succeed in the postsecondary studies that are essential for the anticipated job opportunities? (2) Are North Carolina students preparing to fill STEM jobs and meet the 2018 demand?**

Indicator 21: Percentage of entering freshmen in community colleges that took one or more remedial courses within three years

Metric (2011-2012): 47.0% [116]

Indicator 22: Percentage of community college students who earned a grade of "C" or better in a college course following participation in remedial courses

Metric (2011-12): 42.0% [117]

While many people are dismayed that remedial courses are even needed at the college level, the data above indicate that remedial courses do have some positive benefits. Also promising is the percentage of students earning AA degrees in STEM fields. Not only are community colleges an integral part of our postsecondary system, but also a critical component of STEM education and preparation.

Summary of NC Community Colleges and STEM (2011-2012)

Measurable Indicator	Percentage
Community college freshman who took one or more remedial courses	47%
Community college students who earned a "C" or better after taking a remedial course	42%
Community college students who earned an AA degree *and* an industry-relevant credential and/or diploma in a STEM-related program	45%
AA degrees earned in the NC Community College System in a STEM-related program	31%
STEM graduates from NC's upper division colleges and universities who entered by transferring community college credits into their baccalaureate programs of study	28%

Source: NC Community College Requested Data Analysis

Indicator 23: Percentage of entering freshmen at community colleges in STEM-related AA programs who successfully transferred 30 semester hours or more into an upper level STEM-related program of study

Metric (2011-12): 9% [118]

Indicator 24: Percentage of community college graduates who earn an associate degree *and* who also earn a credential or diploma in a STEM-related field

Metric (2011-12): 45% [119]

Indicator 25: Percentage of community college associate degrees earned in STEM-related programs

Metric (2011-12): 31% [120]

[116-120] NC Community College Requested Data Analysis: www.nccommunitycolleges.edu.

Indicator 26: Percentage of all STEM graduates from North Carolina higher education institutions who entered by transferring community college credit into their baccalaureate programs of study

Metric (2011-12): 28% [121]

Indicator 27: Number of degrees conferred in STEM-related fields for all North Carolina colleges and universities

Metric (2011-12): *Bachelor's:* **12,767 (26%)**; *Master's:* **4,533 (29%)**; *Doctorate:* **97 (58%)**; *Doctoral Professional:* **1,025 (45%)** [122]

Rightfully, North Carolina prides itself on its leadership role in making postsecondary access as reasonable and as opportunistic as possible. The state provides low-cost access to a system of 58 state-sponsored community colleges, geographically distributed to enable any citizen to enroll in a myriad of programs, including nearly 550 with a specific emphasis on a STEM outcome. Our state has an internationally respected system of 15 senior-level colleges and universities, again geographically distributed to facilitate both access and opportunity. North Carolina also is home to a large and diverse array of independent colleges and universities, and the state provides a substantial level of public funds to support citizens who choose to attend independent institutions in North Carolina.

Given the breadth and depth of these postsecondary opportunities, the degree of commitment to study in a STEM field is, at best, only adequate. While nearly a quarter of students who earn an associate's degree do so in a STEM field, only nine percent transfer their credits to a STEM field in an upper-division institution. Of students who attend NC's upper-level colleges and universities,

Number and Percent of Degrees Conferred in STEM Fields for all NC Colleges and Universities (2011-2012)

Degrees	Total	Percent
Bachelor's	12,767	26%
Masters	4,533	29%
Doctorates (Academic)	997	58%
Doctorates (Professional)	1,025	45%

Source: UNC 2010-11 Statistical Abstract of Higher Education in North Carolina

about 26 percent graduate with a bachelor's degree in a STEM field. That percentage rises slightly to 29 percent for master's degrees (2011 data). STEM-related doctorates in North Carolina account for an impressive 58 percent of all academic doctorates awarded, and 45 percent of all professional doctorates, primarily related to the health professions. These data indicate that North Carolina's ability to fill the anticipated job vacancies over the next seven years will come up short. As mentioned earlier, the Lumina Foundation proposed that at least 60 percent of the American workforce have postsecondary degrees or certificates by 2025. According to *Carolina Context* at UNC Chapel Hill: "To reach the 60 percent goal, the state would have to increase by seven percent each year the number of college students who receive associate's or bachelor's degrees—that is, 9,440 more graduates annually between now and 2025." Without any change in the current pattern for producing competent and qualified North Carolinians for STEM jobs, the state will have to continue to rely on being a net *importer* of talent, all while North Carolina citizens compete for fewer and fewer low-wage, low-skill jobs.

26%

The percentage of students who graduate in STEM-related fields for all North Carolina collages and unversities is 26%.

[121,122] UNC 2010-11 Statistical Abstract of Higher Education in North Carolina – Table 42 www.northcarolina.edu/stat_abstract/index.php?pg=dl&id=s12721&inline=1&return_url=%2Fstat_abstract%2Findex.php%3Fpg%3Dtoc%26id%3Ds12666.

60%

A goal set by The Lumina Foundation recommends that 60% of the US adult population have postsecondary degrees or certificates by 2025 to maintain economic leadership in the world. North Carolina's current rate is 36.9%.

Domain Summary

The data presented in this domain reveal a great deal of information and many insights about North Carolina's college and career readiness.

1. Elementary and middle school students appear to possess better than sufficient knowledge in mathematics and science to make successful transitions into secondary subject matter, based on EOG and EOC results. However, the NAEP metrics show that a true measure of capacity in mathematics and science lies somewhere between state assessments and NAEP. Much still needs to done to build mathematics and science capacity in the early and middle grades.
2. To graduate, North Carolina high school students are required to pass four units of mathematics and three units of science, and also achieve a "passing" score on the Algebra I and Biology EOC exams. Data indicate that approximately 75 percent of entering freshmen graduate within four years, all with some degree of academic success in mathematics and science.
3. Over 100 CTE programs with a clear connection to STEM content have been approved.[123] And more than 80 percent of CTE students tested on CTE-related STEM assessments are deemed proficient. Almost 94 percent of CTE graduates enroll in some form of postsecondary education/training.
4. Of special note in the CTE curriculum: high school students can earn an industry or occupational credential or certificate indicating that they have acquired the necessary knowledge and skills to be eligible for an entry-level position in a specific occupational area. Considering only those CTE programs that met the requirements for being STEM related, nearly 25,000 students—over 45 percent—in these programs earned an industrial or occupational certification.
5. Many students with aspirations for postsecondary education take Advanced Placement courses to meet high school graduation requirements and possibly earn college credit while doing so. Of the 10 separate STEM-related AP exams, from biology to statistics, over 57 percent of all AP test takers received a score of 3 or higher, making them potentially eligible to earn a corresponding college credit for their freshman year in college.

[123] For a CTE course to be considered as a STEM-related course, at least 60% of the course content had to require the use of STEM knowledge and applications.

6. In North Carolina, the data on college readiness are mixed. Fifty-six percent of our students meet or exceed the college readiness benchmark in mathematics—with an average ACT score of 22.4—and 34 percent of students meet the benchmark in science—with an average score of 21.4. These scores are both higher than the national average, and also place North Carolina first in the South in mathematics, and second in the South in science. However, compared to the top 10 states in ACT performance, North Carolina lags behind. In a competitive environment where STEM capacity can translate into economic development, we are not in a leadership position nationally.
7. Despite the breadth and depth of postsecondary opportunities in the state, students are not entering STEM fields to the degree necessary to increase the state's capacity to compete. A much broader recruitment effort is needed.
8. Without any change in the current pattern for enrolling students in STEM fields and producing competent and qualified North Carolinians for the STEM careers of the future, employers will have to look elsewhere for the talent and skills they need.

Action Items

1. **Examine student accountability based on Common Core State Standards and Essential State Standards to narrow gaps between state and national assessments.**
2. **Sample students' abilities to understand and apply technological tools for knowledge acquisition and problem solving.**
3. **Develop a recruitment initiative for broader participation in STEM programs, high school CTE programs and community college certificate/diploma programs.**
4. **Use the ACT as a diagnostic tool for 12th grade course taking, especially for under-represented minorities.**
5. **The General Assembly should create a postsecondary loan-forgiveness scholarship program for high school and college graduates from underrepresented minority populations, females, and those who come from families with limited resources, who subsequently commit to earning STEM-related degrees in a NC college or university. The loan will be forgiven through employment in a STEM-related job in NC.**

A less obvious area of concern has to do with participation rates. Populations that do not take AP classes and tests miss out on earning college credit, as well as the content and skills taught in the class. The participation rates by students of color are alarmingly low.

DOMAIN FIVE:

Teacher Quality

The goal: Achieve a sufficient supply of well-prepared STEM teachers whose talents are distributed across a diversity of students and schools.

A wealth of research, both national and international, conducted over the last 20 years provides evidence that the teacher is the single largest in-school determinant of student success.[124] Studies show that in the classrooms of the most effective teachers, students learn at twice the rate they do in the classrooms of other teachers, and students from disadvantaged backgrounds learn just as much as those from advantaged backgrounds. That is why, as Sir Michael Barber, Chief Advisor on Delivery to former British Prime Minister Tony Blair said, "the quality of a country's education system cannot exceed the quality of its teachers."[125] This rings true not only for Britain, but for North Carolina as well. And this is why the STEM ScoreCard draws attention to the evidence of teacher quality in North Carolina, primarily for teachers in years 1-5 out of their teacher preparation program. The general consensus is that the direct effects of teacher preparation are overtaken by local school and district influences somewhere between the third and fifth year of teaching. The STEM ScoreCard also addresses opportunities for high-quality teacher professional development in this and several other domains of the ScoreCard.

While accrediting agencies and others[126] are often more concerned with input measures to assess the quality of teacher preparation, the focus of the STEM ScoreCard is on outputs: (1) evidence of the value-add to student performance in science and mathematics from different "portals of entry" into teaching; (2) evidence gained from annual principal evaluations of teachers; and (3) evidence of teacher persistence and growth in the effectiveness of science and math teachers over their first five years. National Board Certification, a strong indicator of disciplined teacher self-development, is also featured in this domain.

Dr. Charles Thompson and Kristina Patterson of the Carolina Institute for Public Policy at UNC-

Teachers are the single largest in-school determinant of student success.

[124] Rivkin et al. (2005): The Market for Teacher Quality. National Bureau of Economic Research Working Paper 11154; Chetty, R. et al. (2011): The long-term impacts of teachers: Teacher value-added and student outcomes in adulthood. National Bureau of Economic Research Working Paper 17699; Konstantopoulos, S. (2011): Teacher effects in early grades? Evidence from a randomized experiment. Teachers College Record, 113, 1541-1565.

[125] Dylan Williams. How do we prepare students for a world we cannot imagine? Salzburg Global Seminar, Salzburg, Austria. December 6-11, 2011.

[126] National Council on Teacher Quality, which in 2013 gave NC an overall D+ rating on five ratings of teacher quality (not correlated to K-12 student performance) www.nctq.org/stpy11/reports/stpy12_northcarolina_report.pdf.

>50%

More than half of North Carolina's middle and high school mathematics and science teachers scored above the national median on Praxis II Subject Matter Assessments in 2008-2011.

Chapel Hill assembled the data presented in the TQ domain. Thompson and Patterson thank Dr. Lou Fabrizio and Jennifer Preston of the NC Department of Public Instruction for reviewing the data and data descriptions for accuracy. Dr. Charles Coble and Dr. Ken Jenkins developed interpretations and recommendations.

The key question: Does North Carolina have adequate numbers of STEM teachers who are sufficiently prepared to teach their subjects well and who can sustain student achievement growth in STEM content areas? One important indicator to answer that question lies in how well prepared STEM teachers are. Performance on a required nationally normed licensure exam provides some insights.

Indicator 1: Candidate performance on licensure examinations

Metrics: (See table below: 2008-2011)

Licensure Examination Performance

(Percentage of teachers scoring above U.S. Median and NC Qualifying Score)

Subject	U.S. 2008-11 Median	NC Qualifying Score
Mathematics (Middle Grades)	51.20%	97.89%
Mathematics (High School)	59.85%	80.03%
Science (Middle Grades)	52.48%	98.82%
Science – Overall (High School)	61.38%	91.21%
Biology	57.68%	91.38%
Chemistry	68.8%	93.31%
Physics	77.88%	96.15%
Earth Science	58.53%	91.2%

Source: NC Department of Public Instruction data, analyzed by the Carolina Institute for Public Policy

The data in the preceding table reflect all employed teachers in these subject areas in NC during the years referenced. The table shows the percentage of middle grades and high school teachers of mathematics and science who scored above the U.S. Median and above the NC Qualifying Score on the Praxis II Subject Assessment. NC passing percentages are based on 2010-11 teachers who took the Praxis II Subject Assessment required by the state of North Carolina to be licensed in the area in which they are teaching. Not all licensed teachers take the Praxis II Subject Assessment in their content area.[127] The U.S. Median Score was calculated by Educational Testing Service using scores of examinees who took the test between August 1, 2008 and June 30, 2011.[128]

As the data show, more than half of middle and high school teachers of mathematics and science teachers scored above the national median on Praxis II Subject Matter Assessments in the academic years 2008-2011, suggesting that NC teachers do a little better on these examinations than teachers across the country. Much larger percentages scored above the qualifying score set by the North Carolina State Board of Education. Any precipitous action to set the NC qualifying score exactly at the national median would disqualify almost half of middle school and high school teachers of mathematics and science in NC public schools, leaving the schools badly understaffed in these areas. However, over time, the State Board and NCDPI should consider raising the required qualifying scores as a means of strengthening teacher quality in STEM areas.

Indicator 2: Principal's evaluation of teacher proficiency to facilitate learning for their students (NC Teacher Evaluation Process Standard IV)

Metrics: (See table on page 88: 2011-2012)

[127,128] North Carolina Test Requirements, available online at www.ets.org/praxis/nc/requirements.

Average Teacher Pay in the South

The Editorial Page of the March 12, 2013 issue of the *Charlotte Observer* opened with this paragraph: "For 10 years, North Carolina has been getting passed on teacher pay like a stock car with a flat tire. Next will be economic engine failure unless the legislature clues in quickly." The chief argument of the editorial writers, as expressed in the title, appears to be: **Pay teachers like our future depends on it.**

What is the teacher pay picture, exactly? The adjacent table from the NEA "Rankings and Estimates. February 2012" illustrates average teacher pay in the southern states and compared to national figures.

North Carolina's average teacher salary is more than $10,000 below the national average. The state also ranks last on pay hikes over the past 10 years. Salary is not the only factor in determining effectiveness, but it does matter for competing with neighboring states to attract and retain good teachers. For North Carolina to recruit effectively, it has to be in a competitive position, just as it has to be in any other sector of the economy.

Average Teacher Pay in the South
(2011-12 School Year))

State	Pay
Alabama (6th in South)	$47,949
Arkansas (9th in South)	$46,632
Florida (8th in South)	$46,944
Georgia (1st in South)	$52,880*
Louisiana (2nd in South)	$51,381
Mississippi (11th in South)	$41,646
North Carolina (10th in South)	**$45,947****
South Carolina (7th in South)	$47,924
Tennessee (4th in South)	$48,289
Texas (5th in South)	$48,110
Virginia (3rd in South)	$49,869
United States	**$56,383**

* 7th in the U.S.
**47th in the U.S.

56.15%
of all teachers in North Carolina are deemed to be "accomplished or better."

Proficiency on NC Teacher Evaluation Process Standard IV: Teachers Facilitate Learning for Their Students (2011-2012)

	Proficient or Better	Accomplished or Better	Distinguished
All Teachers	97.43%	56.15%	10.13%
Mathematics (Middle Grades)	96.51%	51.50%	7.83%
Mathematics (High School)	96.72%	49.18%	6.82%
Science (Middle Grades)	96.80%	48.60%	6.94%
Science (High School)	96.92%	49.18%	6.83%

Source: NC Department of Public Instruction data, analyzed by the Carolina Institute for Public Policy

The data for the table above are derived from the current principal evaluation instrument developed by the Mid-Continent Regional Education Laboratory (MCREL) and adopted by the State Board of Education, and reflect all employed teachers in these subject areas in NC during the time frame shown. The table shows the proficiency levels of different cohorts of teachers of mathematics and science who were evaluated through the North Carolina Teacher Evaluation Process in 2010-11.[129]

In neither science nor mathematics does the percentage of teachers who are proficient or better differ materially from the average for all teachers, but at both the middle grades and high school levels, a smaller percentage of both science and mathematics teachers are judged "distinguished" by their principals. This may suggest that teachers of science and mathematics do not perform at levels similar to other teachers, but it may also be that because of the more "technical" nature of science and mathematics, principals are less skilled in evaluating teachers in these areas.

Indicator 3: EVAAS estimates of teacher effectiveness

Metrics: (See table below: 2011-2012)

The next table shows the percentage of all teachers and elementary, middle, and high school

EVAAS Estimates of Teacher Effectiveness (2011-2012)
(Percentage of expected growth)

	Above	Below	Meets Expected Growth
All Teachers	15.42%	14.44%	70.15%
Mathematics (Elementary)	14.50%	13.83%	71.67%
Mathematics (Middle Grades)	26.88%	22.81%	50.31%
Mathematics (High School)	23.57%	24.13%	52.31%
Science (Elementary)	18.91%	18.09%	63.00%
Science (Middle Grades)	28.57%	30.10%	41.32%
Science (High School)	29.44%	29.08%	41.48%

Source: NC Department of Public Instruction data, analyzed by the Carolina Institute for Public Policy

[129] North Carolina Teacher Evaluation Process, available online at www.ncpublicschools.org/docs/educatoreffect/ncees/instruments/teach-eval-manual.pdf.

teachers of mathematics and science with an Educational Value Added Assessment System (EVAAS) index score for 2011-12 at each of three levels of effectiveness: (1) below expected growth, (2) at or near the expected growth, or (3) above expected growth in terms of their students' End of Grade (middle school) or End of Course (high school) examination scores.

To assign teachers to a level of effectiveness for mathematics in grades 4-8 (Multivariate Response Model), students' actual test score growth is compared to the growth that would be expected in light of their prior test scores, and the aggregate of these comparisons for a given teacher is compared with the state average for that grade level and subject area. Above Expected Growth indicates that students taught by that teacher exceeded their expected growth by a large margin (more than two standard errors above the statewide average for that grade level and subject area). Below Expected Growth indicates that test score gains by students of that teacher fell substantially below their expected gains (more than two standard errors below the statewide average for that grade level and subject area). Meets Expected Growth indicates that students of that teacher made test score gains fairly close to what would be predicted based on their prior test scores (within two standard errors of the state average for that grade level and subject area).[130]

For science and courses assessed with end-of-course exams, the Univariate Response Model in EVAAS compares how a student performs on the assessment with how other students with similar testing histories have performed on the assessment for the appropriate courses or grades. The same three categories described above are used to categorize an educator's impact as above expected growth, below expected growth, or meeting expected growth.

As students must have prior test scores to be included in calculating EVAAS estimates, the above figures are limited to teachers of 4th-12th grades. "All Teachers" includes teachers of 4th-12th grade courses with an EOG exam, EOC exam, or CTE post-assessment. "Mathematics (Elementary)" includes 4th and 5th grade teachers of students who took the mathematics EOG exam; "Mathematics (Middle Grades)" includes 6th-8th grade mathematics teachers; "Mathematics (High School)" includes 9th-12th grade Algebra I teachers (Algebra I is the only EOC test administered in NC beginning in 2011-12); "Science (Elementary)" includes 5th grade teachers of students who took the science EOG exam; "Science (Middle Grades)" includes 8th grade science teachers; "Science (High School)" includes 9th-12th grade Biology teachers (Biology is the only EOC test administered in NC beginning in 2011-12). The appropriate EVAAS model was used for each combination of subject and grade level.

Because teachers are assigned to one of the three levels of effectiveness by comparing their scores to the state average of all teachers of their subject and grade, it is to be expected that the great majority of teachers will be rated "Meets Expected Growth," and that much smaller percentages will be rated "Below Expected Growth" or "Exceeds Expected Growth." The distribution of ratings may change significantly over time, but for statistical reasons the percentage rated "Below Expected Growth" can never approach zero. Nor can the percentage rated "Exceeds Expected Growth" rise very sharply. It will be by observing small changes over time that this indicator may prove valuable. For an illustration of this, see Indicator 4.

[130] For more information on the EVAAS Statistical Models, see SAS EVAAS Statistical Models, available online at www.sas.com/resources/asset/SAS-EVAAS-Statistical-Models.pdf. For more information on the EVAAS Teacher Reports, see "Making Data Work for Kids: EVAAS Teacher Reports," available online at http://rt3region4.ncdpi.wikispaces.net/EVAAS+Teacher+Report+Resources.

Substantially more teachers in their first year of teaching mathematics in North Carolina produce less than expected growth than is true in years two through five.

Indicator 4: EVAAS estimates of effectiveness by year of experience

Metrics: (See table below: 2011-2012)

EVAAS Estimates of Teacher Effectiveness by Year of Experience (2011-2012)

(Percentage of expected growth)

	Above	Below	Average
Mathematics (Middle Grades)			
1st year teachers	23.08%	31.14%	45.79%
2nd year teachers	28.89%	20.00%	51.11%
3rd year teachers	27.89%	23.90%	48.21%
4th year teachers	31.14%	22.81%	46.05%
5th year teachers	29.76%	18.05%	52.20%
Mathematics (High School)			
1st year teachers	22.29%	30.29%	47.43%
2nd year teachers	24.59%	20.49%	54.92%
3rd year teachers	28.69%	20.49%	50.82%
4th year teachers	31.65%	20.86%	47.48%
5th year teachers	22.52%	22.52%	54.95%
Science (Middle Grades)			
1st year teachers	36.76%	29.41%	33.82%
2nd year teachers	39.53%	27.91%	32.56%
3rd year teachers	30.67%	21.33%	48.00%
4th year teachers	31.31%	32.32%	36.36%
5th year teachers	24.68%	29.87%	45.45%
Science (High School)			
1st year teachers	32.14%	26.19%	41.67%
2nd year teachers	33.33%	20.63%	46.03%
3rd year teachers	33.33%	22.22%	44.44%
4th year teachers	28.92%	22.89%	48.19%
5th year teachers	32.14%	30.95%	36.90%

Source: NC Department of Public Instruction data, analyzed by the Carolina Institute for Public Policy

The 2011-12 EVAAS estimates of teacher effectiveness (explained above) are for teachers in their first through fifth year of teaching and reflect all employed teachers in these subject areas in NC during this time frame. As the table indicates, substantially more teachers in their first year of teaching mathematics produce less than expected growth than is true in years two through five. After the first year, mathematics teachers tend to produce substantially higher growth on a more or less stable basis, other than the apparent diminished effectiveness of fifth-year high school mathematics teachers. There is less of a clear trend among science teachers, particularly in middle grades science.

Indicator 5: Numbers of courses and students taught by mathematics and science teachers who are non-licensed, provisionally licensed or fully licensed in their discipline

Metrics: (See table below: 2010-2011)

A high percentage of teachers teaching science and mathematics at the middle and high schools in North Carolina are not fully licensed in these disciplines.

Numbers of Courses and Students Taught by Mathematics and Science Teachers who are Non-licensed, Provisionally Licensed or Fully Licensed in their Discipline (2010-2011)

		Non-licensed	Provisionally Licensed	Fully Licensed
Mathematics (Middle Grades)				
Courses	19,658	38.29%	10.14%	50.43%
Students	319,514	30.36%	11.33%	57.56%
Mathematics (High School)				
Courses	31,329	32.40%	9.81%	51.21%
Students	372,988	15.90%	11.66%	65.68%
Science (Middle Grades)				
Courses	16,799	37.87%	12.89%	48.03%
Students	319,250	31.69%	13.90%	53.27%
Science (High School)				
Courses	25,049	32.79%	19.01%	45.88%
Students	335,443	16.47%	23.06%	57.37%

Source: NC Department of Public Instruction data, analyzed by the Carolina Institute for Public Policy

The table above shows the percentage of middle grades and high school courses and students taught by a teacher without a license in the discipline he or she is teaching, the percentage of courses and students taught by a teacher with a provisional license, and the percentage of courses and students taught by a fully licensed teacher. A fully licensed teacher has an initial or continuing license in the subject and grade level he or she is teaching. This excludes teachers with a provisional license as well as teachers with a license in the subject area, but for another grade level (i.e., a teacher licensed in Mathematics (Secondary) who is teaching Middle Grades Mathematics is excluded). A provisionally licensed teacher has a provisional license in the subject and grade level he or she is teaching. A teacher without a license in the discipline indicates that the teacher is not licensed in the subject he or she is teaching at either grade level (i.e. a High School Mathematics teacher has neither a Middle Grades Mathematics license nor a Mathematics (Secondary) license). High school course counts are higher as they often indicate two semesters of a course, which are counted as unique courses in the roster data received from the North Carolina Department of Public Instruction.

These data are most revealing. As the table shows, a high percentage of teachers teaching science and mathematics at the middle and high schools in North Carolina are not fully licensed in these disciplines. Many thousands of

312,726

A total of 312,726 middle and high school students in North Carolina are getting STEM content from people not fully licensed to teach their subject.

middle and high school students learn their STEM content from unlicensed and under-prepared teachers teaching classes because someone has to. The numbers translate in this manner. A total of 97,004 middle school students are receiving their math content knowledge, and 101,170 middle school students receiving their science content knowledge, from unlicensed teachers in those disciplines. There are 59,305 high school students receiving math content knowledge and 55,247 high school students receiving science content knowledge from unlicensed teachers in those disciplines. A total of 312,726 middle and high school students are getting STEM content from people not fully licensed to teach their subject. While more middle grades mathematics teachers are fully licensed in their subject area than others in the sample, nearly one-third are teaching mathematics without a license in the discipline. Less than half of North Carolina's high school science teachers are licensed in their discipline. Relative to the question of teacher quality, too many of our young students looking to gain momentum in the pipeline are being handicapped academically.

Over the past five to seven years, the University of North Carolina system has taken steps to increase its production of new teachers, resulting in an increased productivity of new teachers by 53% from UNC institutions. The gains have been in overall teacher productivity, not just in STEM teaching disciplines (those data were not readily available). These gains are a direct outcome of prioritizing the increase of new initially licensed teachers for NC public schools, especially in high-need licensure areas. The outcomes result from a teacher preparation enrollment growth plan and campus-based teacher recruitment plans that are funded based on outcomes. This is clearly a step in the right direction, but to make further and more rapid strides, a program of scholarships or other types of financial aid or incentives may be necessary.

Indicator 6: Teacher effectiveness by preparation category and as compared to all other sources of teachers' experience

Metrics: (See following table: 2005-06 through 2009-10)

Teacher Effectiveness by Preparation Category and as Compared to All Other Sources of Teachers (2005-06 through 2009-10)

	Percentage of All Teachers	Compared to All Other Sources
Mathematics (Middle Grades)		
UNC Undergraduate	33.61%	No Different
UNC Graduate	1.64%	No Different
NC Private Undergraduate	9.95%	Less Effective
NC Private Graduate	0.37%	NR (< 10 teachers)
Out-of-State Degree	28.57%	No Different
Alternative Entry	19.19%	No Different
Teach For America	0.92%	More Effective
Mathematics (High School)		
UNC Undergraduate	36.05%	No Different
UNC Graduate	2.67%	More Effective
NC Private Undergraduate	10.32%	No Different
NC Private Graduate	1.07%	More Effective
Out-of-State Degree	23.51%	No Different
Alternative Entry	19.5%	Less Effective
Teach For America	1.22%	More Effective
Science (Middle Grades)		
UNC Undergraduate	28.78%	No Different
UNC Graduate	1.68%	NR (<10 teachers)
NC Private Undergraduate	9.02%	Less Effective
NC Private Graduate	0.4%	NR (<10 teachers)
Out-of-State Degree	29.45%	No Different
Alternative Entry	23.39%	No Different
Teach For America	1.15%	More Effective
Science (High School)		
UNC Undergraduate	23.18%	No Different
UNC Graduate	3.86%	No Different
NC Private Undergraduate	6.42%	No Different
NC Private Graduate	0.85%	More Effective
Out-of-State Degree	25.43%	No Different
Alternative Entry	31.2%	Less Effective
Teach For America	1.64%	More Effective

Source: NC Department of Public Instruction data, analyzed by the Carolina Institute for Public Policy

Nearly 1/3

of North Carolina's math teachers are teaching without a license in the discipline. Less than half of North Carolina's high school science teachers are licensed in their discipline.

On average, teachers from different portals of entry generally perform similarly, with two exceptions. **Teach For America** teachers were shown to be more effective in every category. And **Alternative Entry** teachers are less effective in both mathematics and science at the high school level.

The preceding table shows the percentage of all teachers of the respective subject and level prepared in each category as well as the effectiveness of early career teachers (i.e., less than five years of experience) by preparation category, in comparison to the aggregate of all other sources of teachers. The Carolina Institute for Public Policy (CIPP) does not report on any category with fewer than ten teachers. For this table, teachers' comparative effectiveness estimates are calculated using a multi-level value added model with extensive student, classroom, and school level controls, adjusted for reliability. The data used for this analysis include the 2005-06 through the 2009-10 school years. The data are restricted to teachers with less than five years of teaching experience, in recognition of the fact that teacher preparation effects diminish over time as a teacher gains classroom experience and principal and peer feedback, and other professional development occurs. For more information on the effectiveness of teacher preparation, please refer to the 2012 report, *UNC Teacher Quality Research: Teacher Portals Effectiveness Analysis*.[131]

Teachers are categorized by the preparation received before entering the classroom. In the preceding table, UNC Undergraduate indicates that a teacher was prepared through a traditional teacher preparation program at a public institution in North Carolina, while NC Private Undergraduate indicates that a teacher was prepared through a traditional teacher preparation program at a private or independent institution in North Carolina. Out-of-State Degree indicates that a teacher received either a bachelor's or a graduate degree from a public or private institution outside of North Carolina. Alternative Entry indicates that prior to entering the classroom, a teacher did not complete a teacher preparation program, nor complete all coursework for licensure prior to entering the classroom. Teach For America indicates the teacher participated in the Teach For America program.[132]

On average, teachers from different portals of entry generally perform similarly, with two exceptions. Teach For America teachers, who, though comprising a small percentage of teachers employed in high poverty, historically low-performing schools in North Carolina, were shown to be more effective in every category. And Alternative Entry teachers are less effective in both mathematics and science at the high school level. In addition to the data included in the table above, we should note that the CIPP has found that at the high school level, NC Teaching Fellows performed more effectively across all subjects combined than did other high school teachers prepared within North Carolina, but at the high school level, CIPP did not conduct separate analyses specific to mathematics or science. CIPP also found that at the middle grades level, NC Teaching Fellows teaching mathematics outperformed other teachers of mathematics prepared within North Carolina. But CIPP has not conducted similar analyses for middle grades teachers of science.

Indicator 7: The persistence of math and science teachers in the first five years of teaching

Metrics: (See following table: 2004-2007)

The next table shows the percentage of all middle and high school teachers and middle and high school teachers of mathematics and science remaining in North Carolina Public Schools for

[131] UNC Teacher Quality Research: Teacher Portals Effectiveness Analysis. (February 2012). Carolina Institute for Public Policy, University of North Carolina at Chapel Hill. http://publicpolicy.unc.edu/research/PortalsEffectivenessReport.pdf).
[132] For more information, see the Teach for America website: www.teachforamerica.org.

The Persistence of Mathematics & Science Teachers in the First Five Years of Teaching (2004-07)

	Stay for 2	Stay for 3	Stay for 4	Stay for 5
All Middle Grades	87.56%	76.16%	65.65%	59.73%
All High School	87.55%	76.84%	65.82%	59.53%
Mathematics (Middle Grades)	87.29%	76.52%	65.66%	61.40%
Mathematics (High School)	86.48%	75.52%	64.84%	59.74%
Science (Middle Grades)	88.65%	78.42%	68.84%	62.70%
Science (High School)	85.79%	71.57%	60.47%	54.86%

Source: NC Department of Public Instruction data, analyzed by the Carolina Institute for Public Policy

two, three, four, and five or more years, respectively. The sample for this table includes three cohorts of beginning teachers—from 2004-05, 2005-06, and 2006-07—that the CIPP could track for at least five years in order to determine teacher persistence.

As the table indicates, mathematics teachers at both middle grades and high school levels demonstrate similar levels of persistence in comparison to overall averages of middle grades and high school teachers, although a slightly higher percentage of middle grades mathematics teachers remain in North Carolina Public Schools for five or more years, as compared to the overall average of teachers of middle grades. Middle grades science teachers demonstrate higher levels of persistence in comparison to overall averages for middle grades teachers, while high school science teachers demonstrate slightly lower levels of persistence in comparison to overall averages for high school teachers. These retention rates are not strikingly low compared to national comparisons, but they do present a challenge to school and district leaders on what actions can be taken to elevate the retention of mathematics and science teachers.[133]

Persistence, or the lack of it, in teaching becomes more urgent when looking back to Indicator 4. Those data showed that teachers generally improve with experience in their first three to five years of teaching. Losing a beginning teacher means having to start over again, perhaps with another beginning teacher, inducting them into teaching and supporting their growth. And not insignificantly, studies done by the National Commission on Teaching for America's Future conclude that it costs school districts about $10,000-12,000 to replace and train a new teacher, which is money and time that could better be applied to more support for improving teachers who persist in teaching.[134]

Indicator 8: Comparative persistence of math and science teachers by preparation category

Metrics: (See following table: 2004-2007)

The following table presents the percentage of middle and high school teachers of mathematics and science remaining in North Carolina Public Schools for two, three, four, and five or more years, respectively, by preparation category.

$10K-12K

Studies done by the National Commission on Teaching for America's Future conclude that it costs school districts about $10,000-12,000 to replace and train a new teacher.

[133] Ingersoll, Richard M. and May, Henry. The Magnitude, Destinations, and Determinants of Mathematics and Science Teacher Turnover. Educational Evaluation and Policy Analysis, v34 n4 p435-464, Dec 2012 (see note below).
[134] http://nctaf.org/wp-content/uploads/2012/01/NCTAF-Who-Will-Teach-Experience-Matters-2010-Report.pdf.

Teachers prepared in both public and private undergraduate programs within North Carolina demonstrate higher levels of persistence in both mathematics and science at both the middle grades and high school levels than Out-of-State prepared teachers, Alternative Entry teachers and Teach For America teachers.

Comparative Persistence, in Years, of Math and Science Teachers by Preparation Category (2004-07)

Years remaining in job	2 years	3 years	4 years	5 years
Mathematics (Middle Grades)				
UNC Undergraduate	93.84%	89.44%	83.87%	76.25%
UNC Graduate	100%	100%	92.31%	84.62%
NC Private Undergraduate	96.05%	89.47%	77.63%	72.37%
NC Private Graduate	NR	NR	NR	NR
Out-of-State Degree	83.07%	76.77%	69.29%	64.17%
Alternative Entry	82.11%	69.69%	59.16%	56.84%
Teach For America	92.86%	35.71%	19.05%	16.67%
NC Teaching Fellows	100%	97.18%	88.73%	80.28%
Mathematics (High School)				
UNC Undergraduate	96.41%	91.50%	85.29%	81.05%
UNC Graduate	88.89%	81.48%	66.67%	44.44%
NC Private Undergraduate	94.57%	88.04%	81.52%	73.91%
NC Private Graduate	100%	80%	80%	40%
Out-of-State Degree	88.63%	76.70%	65.91%	55.68%
Alternative Entry	74.61%	60.99%	50%	48.17%
Teach For America	100%	36.84%	26.32%	26.32%
NC Teaching Fellows	95.69%	90.52%	87.07%	75.86%
Science (Middle Grades)				
UNC Undergraduate	95.92%	91.84%	86.94%	80.41%
UNC Graduate	88.24%	88.24%	70.59%	41.18%
NC Private Undergraduate	91.18%	83.82%	69.12%	69.12%
NC Private Graduate	NR	NR	NR	NR
Out-of-State Degree	88.66%	83.40%	78.14%	68.02%
Alternative Entry	83.03%	69.67%	60.67%	56.81%
Teach For America	95.65%	30.43%	26.09%	21.74%
NC Teaching Fellows	100%	95.24%	85.71%	76.19%
Science (High School)				
UNC Undergraduate	92.21%	86.36%	80.52%	74.03%
UNC Graduate	75.76%	66.67%	57.58%	48.48%
NC Private Undergraduate	89.74%	79.49%	74.36%	64.10%
NC Private Graduate	NR	NR	NR	NR
Out-of-State Degree	86.01%	67.83%	61.54%	53.15%
Alternative Entry	82.52%	70.20%	58.17%	55.01%
Teach For America	86.21%	17.24%	6.90%	0%
NC Teaching Fellows	97.67%	90.70%	86.05%	72.09%

Source: NC Department of Public Instruction data, analyzed by the Carolina Institute for Public Policy

The sample for this table includes three cohorts of beginning teachers—from 2004-05, 2005-06, and 2006-07—that the CIPP could track for at least five years in order to determine teacher persistence.

As the table indicates, teachers prepared in both public and private undergraduate programs within North Carolina demonstrate higher levels of persistence in both mathematics and science at both the middle grades and high school levels than Out-of-State prepared teachers, Alternative Entry teachers and Teach For America teachers.

In both mathematics and science at both the middle and high school levels, NC Teaching Fellows persisted in NC schools at higher rates than did teachers prepared out of state, Alternative Entry teachers, or Teach For America teachers. In middle grades mathematics, NC Teaching Fellows persisted at slightly higher rates than UNC undergraduate-prepared teachers as a group, but persisted at slightly lower rates in high school mathematics and in science at both the middle and high school levels.

Teach For America teachers demonstrate very low levels of persistence in comparison to all other sources of teachers beyond the second year of teaching required by the program.

Indicator 9: Percent of middle grades and high school mathematics, science and elementary level National Board Certified Teachers in North Carolina

Metrics: (See following table: January, 2013)

The National Board for Professional Teaching Standards (a voluntary, independent, non-profit organization) seeks to elevate the status, voice, and role of accomplished teachers in shaping a true profession. Efforts include: (1) raising public awareness with respect to the cognitively complex, collaborative, and expertise-driven nature of teachers' work; (2) setting higher standards for entry, advancement, and leadership in the profession; and (3) recognizing accomplished teaching through a rigorous professional certification process comparable to those found in other professions such as medicine, engineering, and law.

The table above shows the percentage of teachers with National Board Certification.[135] National Board Certificate areas do not align explicitly with subjects and grade levels as defined in this report, however, North Carolina ranks first out of 52 states and territories in the number of Nationally Board Certified teachers in all relevant National Board Certificate areas, except for Early Adolescence Science, in which North Carolina ranks second, only slightly behind Florida.

Percentage of NC Teachers with National Board Certification (Jan. 2013)

Level/Subject	Certified
Elementary	9.45%
Mathematics (Middle Grades)	11.60%
Mathematics (High School)	14.25%
Science (Middle Grades)	10.53%
Science (High School)	14.91%

Source: The National Board for Professional Teaching Standards, Washington, DC and the NC Department of Public Instruction

#1

North Carolina ranks 1st out of 52 states and territories in number of Nationally Board Certified teachers in all relevant National Board Certificate areas, except for Early Adolescence Science, in which North Carolina ranks 2nd, only slightly behind Florida.

[135] For more information on National Board Certification and Certificate areas, see the National Board for Professional Teaching Standards website: www.nbpts.org.

There is a substantive body of research that suggests a disproportionate number of these unprepared or underprepared teachers teach in classrooms and schools most heavily populated by our most challenged and hard-to-teach students.

Domain Summary

This domain is particularly complex, perhaps reflective of the teaching profession in North Carolina as a whole. There are many avenues into teaching in North Carolina and some of those portals of entry, as described, have consequences for student achievement and teacher turnover. Of greatest concern is that one can teach the conceptually challenging disciplines of science and mathematics without a license in the subject areas, a practice unthinkable in other professions. So, what conclusions might we draw from this analysis on Teacher Quality and what actions do we suggest?

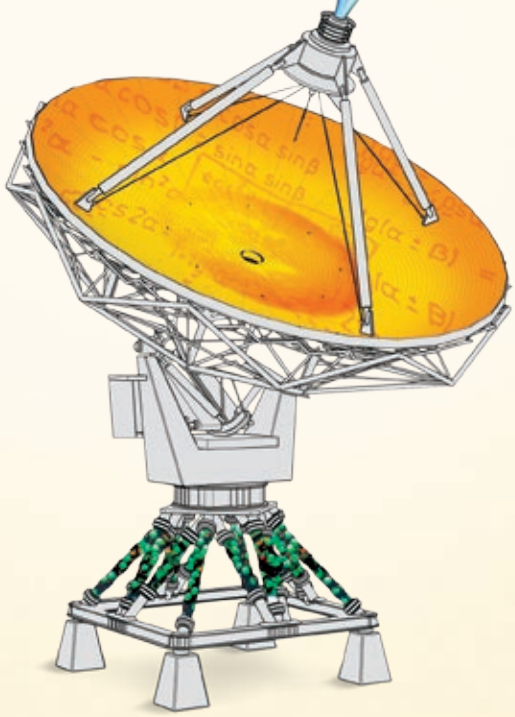
1. For some time, North Carolina has not produced a sufficient supply of teachers eligible for full licensure in mathematics and the sciences to meet demand. Given the under-supply of fully licensed math and science teachers, schools and districts turn to underprepared and/or under-developed out-of-field teachers to teach these critically important subjects. A substantive body of research suggests that a disproportionate number of these unprepared or underprepared teachers teach in classrooms and schools most heavily populated by our most challenged and hard-to-teach students.
2. Success on meeting state standards on licensure standards is a mixed bag. New teachers do well in meeting or exceeding the state's cut-off score on the PRAXIS II exams and more than half meet or exceed the national averages on these exams. The latter indicates that our teachers of mathematics and science score as well or better than teachers from other states.
3. Some significant if not dramatic differences exist between the portals of entry into teaching. UNC institution and other in-state teachers generally perform similarly to other teachers. But, Teach For America teachers are more effective at every level, and Alternative Entry teachers are less effective in high school mathematics and science. North Carolina has a substantial reliance on staffing STEM classrooms with less effective Alternative Entry and out-of-state prepared teachers, a reliance that might operate to the detriment of STEM learning in middle and high school students.
4. UNC institutions and the state's independent colleges and universities provide far and away the greatest number of mathematics and science teachers and they are retained in higher percentages than any other portal of entry into teaching in North Carolina.
5. As previously noted, Teach For America's teachers were consistently found to be more effective in comparison to all other portals of entry. That is laudable, as is their ethos to teach in the most needy schools. However, these teachers comprise a tiny portion of the state's teaching force and primarily serve for only two years, although some TFA teachers stay longer and seek avenues for full licensure.
6. As a national leader in National Board (NB) Certified teachers, North Carolina has clearly and historically shown a commitment to finding and rewarding its best teachers. Even with the once available NB stipend gone because of budget issues, North Carolina's teachers *still* seek and acquire this very rigorous and demanding certification.

Action Items

1. **The General Assembly should move quickly to increase teacher pay generally in North Carolina to reverse our non-competitive position in the South and to implement a differentiated pay structure for science/mathematics teachers to help retain them.**
2. **Expand the Forgivable Education Loans for Service (FELS) program for accomplished students at community colleges, four-year colleges and universities, and mid-career adults who commit to teaching STEM content in high-need schools in North Carolina.**
3. **Policymakers should create additional incentives for public and private institutions to provide accessible programs leading to full licensure of the many out-of-field STEM teachers in North Carolina.**
4. **Develop deeper collaboration between districts and colleges and universities to mutually encourage and support increases in quality "grow-your-own" models of STEM teacher preparation.**
5. **Strengthen the mentoring and induction of beginning STEM teachers and enact other measures to maximize their success and retention.**

DOMAIN SIX:

Leadership and Policy Support



The goal: Public school districts and affiliated schools should communicate a focus on STEM education and monitor that focus to support high-quality outcomes.

Leadership matters, and, where children's education is concerned, leadership priorities most often translate into programs and practices that reflect those priorities. A general leadership axiom is: "What the leader honors will be honored in the organization." It is our contention that where STEM initiatives have a visible and public presence, that presence communicates a priority by leaders in the organization no matter what its business is.

The key question is: To what degree and in what ways do the public school districts, the NC Chamber of Commerce, the Golden Leaf Foundation, and other statewide initiatives communicate the priority for and support of STEM outcomes from entry into and exit from the STEM pipeline?

This first section, which focuses on Leadership and Policy Support in School Districts, presents results of a survey on practices that are indicative of STEM engagement and support. All 115 school districts in the state were surveyed, with the approval and support of the North Carolina Association of School Administrators and its affiliated North Carolina School Superintendents Association.

Of the 115 surveys distributed, 72 were returned, yielding a return rate of 62.6 percent.

Indicator 1: Percent of districts that have a STEM-specific focus on the district website

Metric (2011-12): 51.4% [136]

Indicator 2: Percent of districts that include STEM education as a priority in their institutional strategic plan

Metric (2011-12): 62.7% [137]

Summary of School District Survey Responses

Selected Indicator	Percentage "Yes"
STEM-specific focus on the district's website	**51.4%**
STEM Advisory Council or Committee	**40.3%**
Encourage student participation in STEM functions and competitions	**93.8%**
STEM education is a priority in the district's strategic plan	**62.7%**
Schools make use of project-based learning to integrate STEM disciplines	**76.6%**

93.8% of North Carolina school districts that responded to our survey encourage student participation in STEM functions and competitions. But only 40.3% have a STEM advisory council or committee.

[136,137] SMT Center-sponsored survey distributed to all 115 NC public school district superintendents.

Task Force

Asheboro City Schools district has a broadly represented "task force" that advised them on securing a grant from the Golden Leaf Foundation. Activities spawned by this initiative include STEM summer enrichment camps and monthly enrichment activities for middle school students, and professional development for teachers.

Indicator 3: Percent of districts that enable rigorous STEM activity by sponsoring appropriate and focused professional development and providing a working technology infrastructure

Metric (2011-12): 73.8% [138]

Indicator 4: Percent of districts that actively seek STEM-related partnerships for teacher professional development and student internships (where possible)

Metric (2011-12): 79.7% [139]

Indicator 5: Percent of districts that seek opportunities to collaborate with postsecondary learning centers to better align priorities for learning and teaching with postsecondary expectations and workforce performance requirements

Metric (2011-12): 86.2% [140]

Indicator 6: Percent of districts that seek opportunities to secure additional STEM resources through grants, partnerships, and other collaborative ventures and initiatives

Metric (2011-12): 81.3% [141]

For Indicator 6 each district superintendent was asked if he/she was willing to share information about efforts that produced additional resources for their STEM activities. Several responded with highly specific information, as summarized below.

Asheboro City Schools has a "task force" of broad representation that serves to advise the district on securing a grant from The Golden Leaf Foundation. Activities for this initiative include STEM summer enrichment camps for middle school students, monthly enrichment activities for middle school students and teacher professional development. The district also has a CTE Advisory Council, which helped move the district's STEM focus forward through new course offerings in robotics, engineering, biotechnology, and health careers.

Alleghany County Schools has a STEM advisory group made up of teachers, school and district administrators, community college representatives and local government officials. STEM efforts in the district include: Golden Leaf funding; a Burroughs Wellcome Career Award winner; integration of STEM subjects into the afterschool program; and state awards for the robotics and solar powered transportation teams, with their solar cars displayed at the NC Museum of Natural Sciences for the past two years.

Moore County Schools received a STEM-infusion grant from the Mebane Foundation to provide professional development for inquiry-based instruction in STEM disciplines. The district is also one of seven districts that are part of an Investing In Innovation (i3) grant coordinated in this state by the North Carolina Science, Mathematics, and Technology Education Center to provide teacher professional development for STEM instruction, the purchase and implementation of Science and Technology Concept kits, and the implementation of science notebooking. The other districts are Cleveland, Greene, Johnston, McDowell, Warren and Wilson.

[138-141] SMT Center-sponsored survey distributed to all 115 NC public school district superintendents.

Beaufort County Schools has secured external funding to support a Teachers and Administrators Partnering for Mathematics Learning (TAP-Math) grant. The district also received a NC Math-Science Partnership Grant with East Carolina University to improve both content and pedagogical practices in the physical sciences. They have received two different NC-QUEST grants to strengthen content knowledge and pedagogical practices in mathematics as well as to strengthen content knowledge and pedagogical practices in earth science and scientific literacy.

Caldwell County Schools administrators and Board of Education used local and external funding sources to transform a one-time private school facility into the district-wide Patterson Science Center. At the Center students can participate in a series of hands-on science experiences. The district's focus for these resources has been threefold: professional development, program development, and materials/equipment acquisition.

Indicator 7: Percent of districts that have established and/or actively participate in a broadly representative STEM task force with the authority to make recommendations on improving STEM outcomes to the Superintendent and Board

Metric (2011-12): 40.3% [142]

The responses for Indicator 7 revealed a mix of adequate to strong support for STEM in the school districts. Less than two-thirds of respondents have a STEM priority as a part of their district's strategic plan. Professional development in STEM subjects ranks high, and efforts are underway to secure external funding to support STEM initiatives. Also, seeking STEM partnerships appears to be a strength.

Indicator 8: Percent of districts that sponsor or encourage participation in STEM-related functions (e.g., science fairs, robotics competitions, etc.)

Metric (2011-12): 93.8% [143]

Indicator 9: Percent of schools that, in some or most cases, include STEM activities as a priority in the school's improvement plan submitted for district approval

Metric (2011-12): 73.9% [144]

Indicator 10: Percent of schools that report the use of project-based learning in integrating STEM learning into the general curriculum and instructional program

Metric (2011-12): 76.6% [145]

When district leaders oversee school-based initiatives, positive results ensue. About 75 percent of districts reported that the initiatives in Indicators 8-10 were being promoted in schools. STEM education plays a serious and significant part of the public school experience, and district leaders seem to understand that, particularly at the school level. Districts will do well to have knowledgeable people to continually advocate for STEM education and activities.

76.6% of North Carolina schools report the use of project-based learning in integrating STEM learning into the general curriculum and instructional program.

[142-145] SMT Center-sponsored survey distributed to all 115 NC public school district superintendents.

$4,000,000

The Golden Leaf Foundation launched a $4,000,000 STEM initiative in 2010-11 to provide three-year grants of up to $750,000 to help develop STEM capacity for middle schoolers.

Other Sources of Support

Indicator 11: STEM support from the Golden Leaf Foundation

Metric (2011-12): Variable

The Golden Leaf Foundation has launched a $4 million initiative to help prepare North Carolina's middle school students to acquire the knowledge and skills they will need to develop career-readiness in STEM-intensive occupations. Organizations can receive grants up to $750,000 spread over a three-year period. Priority will be awarded to proposals that serve underrepresented minorities, females, and other students who come from limited resources environments, and also that promote collaboration among partners, as well as a curricular focus on integrated curriculum approaches and inquiry- and project-based learning. Notable examples include the following:

In **Lenoir County**, the Foundation is supporting an initiative to create an interactive Algebra lab that helps connect mathematical concepts to real-world situations, such as nutrition, environmental issues, and even sports statistics. The Foundation has supported similar labs in **Craven**, **Wayne**, and **Jones Counties**.[146]

In schools in **Cabarrus County**, **Kannapolis City**, **Richmond County**, and **Rowan-Salisbury**, over 250 middle grades students participate in the BioMoto STEM Challenge, in conjunction with the North Carolina Biotechnology Center and the North Carolina Motorsports Association. While the main intent is to introduce students to the science behind motor sports, they also learn how the STEM disciplines interact, the importance of nutrition and fitness, as well as teamwork and creativity.[147]

Rockingham County Schools are using their STEM grant to increase the use of hands-on, problem-based learning in STEM subjects. They also use the Golden Leaf resources to send students to a robotics camp at North Carolina A&T State University, where students use LEGOS to build robots.[148]

In **Wayne County Schools**, officials are opening STEM Centers at four middle schools. Foundation support will provide instructional materials, equipment, and professional development to provide problem-based learning as well as increase competency in Algebra I—generally regarded as a key indicator of STEM success.

Indicator 12: NC Chamber

Metric: North Carolina Vision 2030

The **NC Chamber** has drafted a comprehensive plan for accelerating job growth in North Carolina. Chamber leaders frame their vision around four "pillars of a secure future," one of which is Education and Talent Supply. This pillar calls for North Carolina to develop and maintain first-rate, leading education and workforce development systems that are effective, accountable, flexible, and consistently produce a competitive, diverse, world-class workforce—exactly what this ScoreCard advocates. The Chamber has an essential role in helping to shape the STEM policies and programs that will contribute to positive consequences for the state.

[146] www2.wnct.com/news/2012/nov/14/3/lenoir-county-school-uses-interactive-lab-learn-al-ar-2780878.
[147] wraltechwire.com/biomoto-STEM-challenge-revs-up-students/11738136.
[148] www.newsadvance.com/rockingham_now/news/eden_reidsville/article_32987246-449f-11e2-a23f-0019bb30f31a.html.

Domain Summary

The survey responses from school districts throughout the state provided a great deal of information about how important STEM education and activities are, and what efforts are being undertaken to foster STEM literacy.

1. North Carolina school districts reported district-level support for STEM initiatives and programs to varying degrees throughout the state. We anticipate greater interest and activity as STEM education receives more attention from state, district and institution leaders.
2. Over 90 percent of school districts reported particularly strong support for sponsoring and/or enabling student engagement and participation in STEM-related programs, such as science fairs and STEM-subject competitions.
3. Support for teacher professional development for improving STEM instruction is very strong, reported by 70-75 percent of districts. Survey results also indicated solid support—in 75-80 percent of districts—for seeking partnerships and collaborations with business enterprises and higher education institutions.
4. The survey results revealed strong district support for instructional practices associated with STEM best practices. Over 75 percent of districts reported the use of project-based learning as a means to integrate STEM subjects and deliver instruction in an integrated manner. Project-based learning is one of several hallmark criteria that defines high-quality STEM instructional delivery.
5. Over 70 percent of districts reported STEM-related priorities as part of school improvement plans.
6. Sixty percent of districts indicated that STEM education is a priority in the district's strategic plan and just over 50 percent reported some form of a STEM focus on the district's website.
7. About 40 percent of the districts indicated that they have a broadly representative external STEM committee or task force with the authority to make recommendations for improving STEM outcomes to the superintendent and Board.
8. The Golden Leaf Foundation should be recognized for making conscientious and generous effort to help build STEM engagement and capacity in school districts throughout the state, particularly for under-represented ethnic minorities, females, and children from low-resources homes.
9. The NC Chamber also should receive credit for its participation in policy and program developments that will contribute to North Carolina's economic future. The Chamber recognizes the connections between its vision for North Carolina's economic future and the many ways the state can and should prepare for that future.

40% **of North Carolina school districts reported having a broadly representative external STEM committee or task force with the authority to make recommendations for improving STEM outcomes to the superintendent and Board.**

District leaders recognize that teacher knowledge and instructional practice in STEM content needs to be improved in order for student achievement to improve. What is not so obvious are indications of any sense of urgency across the districts to elevate their focus on the probable futures of the students they serve.

In summary, school districts across the state are aware of the importance of improving STEM education and literacy for their students, and the need to support efforts that increase both access to and opportunities for STEM learning. District leaders also recognize that teacher knowledge and instructional practice in STEM content needs to be improved in order for student achievement to improve. What is not evident from the survey results is any sense of urgency in the districts to elevate their focus on the probable futures of their students. Increasing the level of STEM engagement in young people is a primary responsibility of schools, and the capacity to accomplish this must be expanded. Education and economic development are symbiotic, not separate, and that is a realization still in need of greater attention.

Action Items

1. **Build collaboration between the NC Chamber's work on the Education and Talent Supply pillar with other STEM partners in the state.**
2. **Encourage the NC Association of School Administrators and its affiliates to assume a leadership role to advocate for making STEM learning a central priority.**
3. **Engage business and higher education partners to sponsor and provide STEM-focused professional development opportunities.**
4. **Encourage the leadership of the UNC system and the independent colleges and universities to initiate reforms in the curriculum and teaching of undergraduate science and mathematics courses.**
5. **Challenge North Carolina's grant makers to expand STEM engagement and learning opportunities for children from under-represented minorities, females, and children from low-income families.**

Priority Action Items

The economic future of this North Carolina rests with a well-educated and well-prepared work-force, particularly those STEM occupations that require higher levels of education, knowledge and skills. State, education, and business leaders need to ensure that all citizens have opportunity and access to the education and preparation for the STEM jobs of the future, irrespective of geography, gender, ethnicity, or age. The STEM ScoreCard Project Team has developed six final *Priority Action Items*, one for each domain, presented on the following pages.

Priority Action Items

1. STEM Workforce and Economic Impact

A broad-based public-private partnership should be convened to increase public awareness and build public support for a broad range of actions to increase STEM capacity across North Carolina.

2. Informal Education and STEM Literacy

The vibrant community of informal learning resources across North Carolina must be leveraged through stronger networks and deeper collaborations with PreK-12, higher education and the business community to measurably increase STEM literacy and career preparation.

3. Strategic Investments and Innovation

Learning in schools will soon be characterized by students with constantly connected mobile devices, requiring ubiquitous wireless access. All districts in North Carolina should have adequate and equal connectivity to NCREN, and schools at every level—elementary, middle and high—should have high-speed connections to the district network. A concerted effort also must be undertaken to ensure that all students have broadband access at home by the 2016-17 school year when the state will migrate to digital textbooks and assessments.

4. College and Career Readiness

The General Assembly should create a postsecondary loan-forgiveness scholarship program for high school and college graduates from underrepresented minority populations, females, and those who come from families with limited resources. Loan recipients would commit to earning stem-related degrees in a NC college or university; loans will be forgiven through employment in a STEM-related job in the state.

5. Teacher Quality

The State Board of Education (SBE) should take immediate action to ensure that all teachers, especially science and mathematics teachers, are fully licensed in their disciplines. Higher education institutions should significantly increase access to content courses to help reduce out-of-field STEM teaching to near zero within five years. Most importantly, the SBE should develop and the General Assembly should fund a differentiated pay schedule for fully licensed science and mathematics teachers within two years.

Centers of Excellence in STEM Teacher Preparation should be established through six to eight regional consortia of community colleges, public and private institutions and public schools toward a goal of reducing duplication, leveraging resources and meeting 100 percent of the demand for fully licensed STEM teachers within five years.

6. Leadership and Policy Support

The NC Association of School Administrators, the NC School Superintendents Association and the NC School Boards Association must take a more active role in advancing STEM education as a strategic priority in North Carolina's schools. These organizations and others must provide professional development for school leaders and board members to learn about and adopt best practices in STEM education.

Capstone Recommendation

The Governor and/or the General Assembly should appoint and empower a new Commission on STEM and the Economy, with the specific responsibility to drive and coordinate state initiatives to make the findings and recommendations in this ScoreCard actionable. This Commission, similar to other state boards and commissions, should be vested with the authority to engage and guide state leaders towards improving the connections and the benefits between STEM capacity and economic development. This Commission on STEM and the Economy should be broadly representative of the state organizations that have vested interests in building these connections.

Closing Reflections

North Carolina has the possibility of a very bright economic future by building on its strengths and history if the deficiencies identified through research can be addressed.

North Carolina has the possibility of a very bright economic future by building on its strengths and history assets if the deficiencies identified through research can be addressed. The state has a well-established infrastructure of informal and formal learning opportunities to engage young people and students in STEM learning. It has a wide-range of well-distributed educational institutions across the state to develop and sustain STEM knowledge and skills. It has programs to strengthen STEM literacy and to keep adults informed of STEM career possibilities. And North Carolina has a wide variety of excellent STEM-related innovations and investments.

However, these realities exist as well:

* While the many different stem organizations and programs are somewhat aware of each other's work, better collaboration across business, government and formal and informal education sectors would help promote broader prosperity across the state.
* Too many middle and high school students are receiving STEM knowledge and skills from well-meaning but ill-prepared adults through alternative and out-of-state preparation programs. The state needs to invest in increasing the supply of highly qualified STEM teachers being prepared by our colleges and universities.
* As is true across the nation, North Carolina has increasing health care and allied health care needs that are not being addressed comprehensively. The issue is exacerbated by the under-supply of allied health professionals and the shortage of primary care physicians produced within our institutions. All postsecondary institutions in the state are working to alleviate these shortages, and should be supported in their efforts.
* High-speed Internet access is an essential tool for a vibrant and equitable economic future for North Carolina. Our state and business interests need to double their investments and leverage federal funding to extend this critical asset across the state.
* Like many states, North Carolina does not ensure that underrepresented population groups are as able to make their way through the STEM pipeline as anyone else. The persistent achievement gaps and the lack of access and opportunity for racial and ethnic minorities and low-income and poor families is not just a social justice issue—it is a critical economic issue for North Carolina. The 2010 U.S. Census reported that the state has approximately 1.3 million citizens between the ages of 15-24 and this included more minorities than at any time in modern history. They are the North Carolinians we must attract and prepare for the STEM jobs of the future.

Acknowledgments

The Project Team is pleased to acknowledge the large number of people and organizations (listed below) that gave their time, talent and attention to help develop this first comprehensive statewide STEM assessment for North Carolina. We express our deepest appreciation and respect for the assistance provided to us as we were pointed to needed information, or given data directly for our use. This generosity work made our work possible. Thank you!

A complete list of individuals with titles and organizational affiliations is presented in the full ScoreCard. We regret if we inadvertently omitted anyone who provided or wished to provide assistance to this project. Future ScoreCards are planned, so we welcome comments and suggestions for improvement.

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