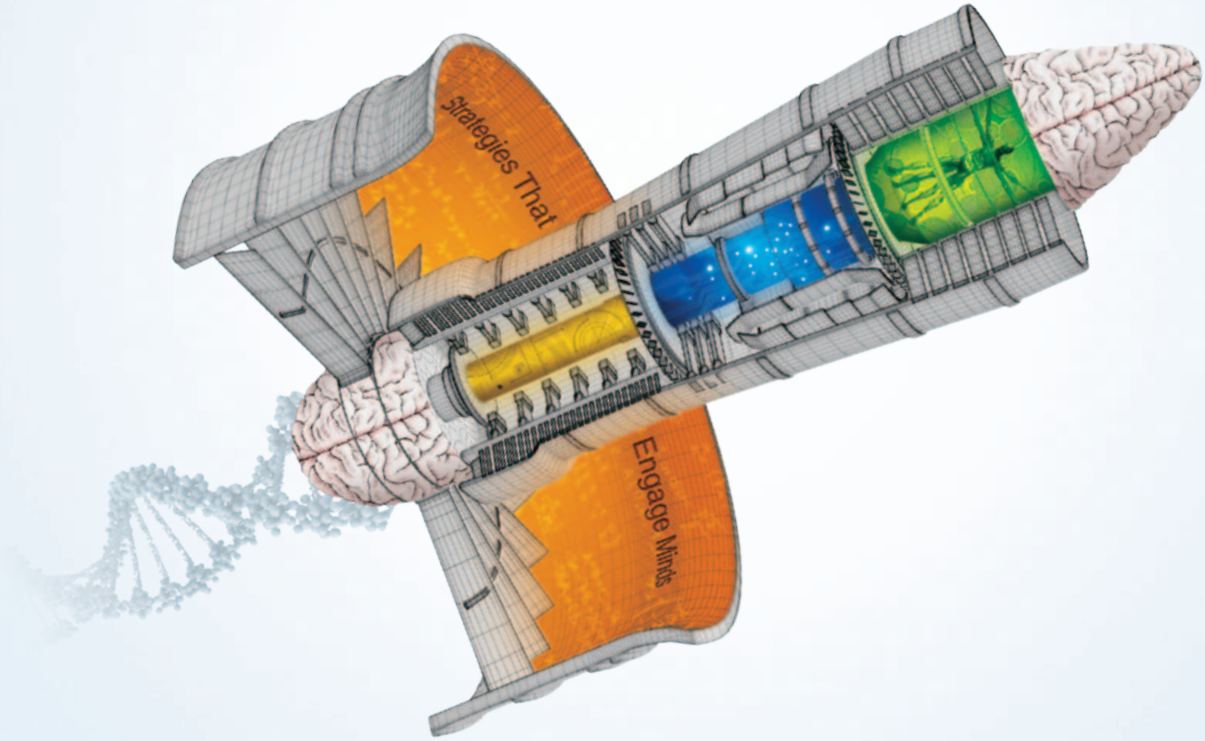
Strategies That Engage Minds®

Empowering North Carolina's Economic Future



SMT
North Carolina Science,
Mathematics, and Technology
Education Center

This ScoreCard was developed under the collaborative support of Dr. June Atkinson, North Carolina State Superintendent of Public Instruction, Dr. Scott Ralls, President, North Carolina Community College System, Mr. Tom Ross, President, University of North Carolina System, and Dr. Sam Houston, President and CEO, North Carolina Science, Mathematics, and Technology Education Center. Additional support was provided by the Burroughs Wellcome Fund of Durham, North Carolina as well as a grant from the Battelle Memorial Institute of Columbus, Ohio.

Contents

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 directions do we take from here?**

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

More than a hundred people and organizations have contributed to the development of this first-ever NC STEM ScoreCard. They helped craft it, provide data for it and will be impacted by the decisions that flow from those who examine and take actions on the recommendations in the ScoreCard. In the full ScoreCard they are acknowledged, but we thank them here as well.

The Purpose

The NC STEM ScoreCard, in this inaugural year, asks three essential questions, the answers to which establish a baseline of data to the questions about readiness and direction:

* 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?
* What evidence do we have that North Carolina is developing STEM literacy in all of its citizens so they can understand and make informed decisions about changes in their world?
* What evidence do we have that North Carolina is developing career opportunities for STEM-prepared adults?

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

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 for examining our state across the education, business, non-profit, and government sectors, and for assessing STEM-related educational and economic progress in North Carolina.

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*®.

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 question and act as responsible citizens. The formal and informal education of children, students and adults work 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.[1] 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 STEM knowledge and skills throughout one's career, strategic investments must be provided from both public and non-public sources in North Carolina.

To understand how well North Carolina is prepared to meet the challenges and opportunities of this system, the ScoreCard is organized around six domains of STEM preparedness: (1) STEM Workforce and Economic Impact; (2) Informal Education and STEM Literacy; (3) Strategic Investments and Innovation; (4) College and Career Readiness; (5) Teacher Quality; and (6) Leadership and Policy Support.

Engagement

STEM interest and learning begins very early as we all come into the world naturally curious. This fundamental disposition drives STEM learning, 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, like building model rockets. Engagement can also come from watching STEM programs on public access television, like Curious George, Nature and Nova, and through reading magazines

[1] 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.

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 post-secondary 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 for students to provide 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 aligned assessments to determine outcomes. It is essential for high school graduation requirements to align with college and university entry requirements. Post-secondary 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

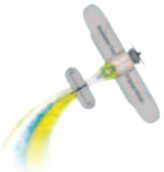
Persistence and continuity matter throughout the STEM pipeline of development so that young learners, who become interested and engaged in STEM subjects and disciplines can continue to develop their interest. The role of clubs, student competitions in science, mathematics, and technology, and schools focused on math and science are key to nurturing student knowledge and interest and translating that knowledge and abilities into preparation for STEM-related careers. Persistence in STEM careers in North Carolina requires policies that capitalize on the public and private investments in the formal and informal STEM education of students and adults. Knowledge, particularly STEM knowledge, changes so rapidly. Continuous learning is a critical part of economic development. The aphorism about preparing people for jobs not yet invented is no longer theory but the current reality.

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. 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 developing 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 post-secondary success in STEM-related job opportunities.

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 are profiles 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.

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.

Introduction to the ScoreCard Analysis

Economic Projections for North Carolina — 2018-2020

By 2018 the number of STEM jobs will increase by at least 17%. This projection excludes growth in the medical and allied health occupations.

The main purpose of the STEM ScoreCard is to assess how well prepared North Carolina's citizens are to meet the economic and educational realities projected for the rest of the second decade of the 21st century. In the full version of the STEM ScoreCard, Guillory and Quinterno[1] provide an incisive and insightful demographic profile and economic status of the state in *North Carolina: The Shape of Its Change*. The key points are that N.C. is 1) growing older, 2) growing multi-ethnic, 3) growing more metropolitan, 4) growing in the importance of place, 5) growing more educated, and 6) growing apart, economically. The bulleted points below are selected 'good news' and 'bad news' data points that are affected by Guillory's and Quinterno's six trends.

* By 2018, approximately **1.4 million job vacancies** are projected for North Carolina, either from new job creation or from retirements.
* Of those vacancies, about **833,000 will require some post-secondary education**. Indeed, approximately 59% of all jobs (2.9 million) in 2018 in North Carolina will require post-secondary education. Most of the state's economic engine will be fueled by these jobs.
* North Carolina will have **more job growth requiring post-secondary education** than most of the South and Southwest.
* The percent of North Carolinians with no high school diploma has dropped from over 30% in 1990 to just over 15% in 2020.
* The occupational areas anticipated to grow most rapidly include **medical and allied health** and computer technology.

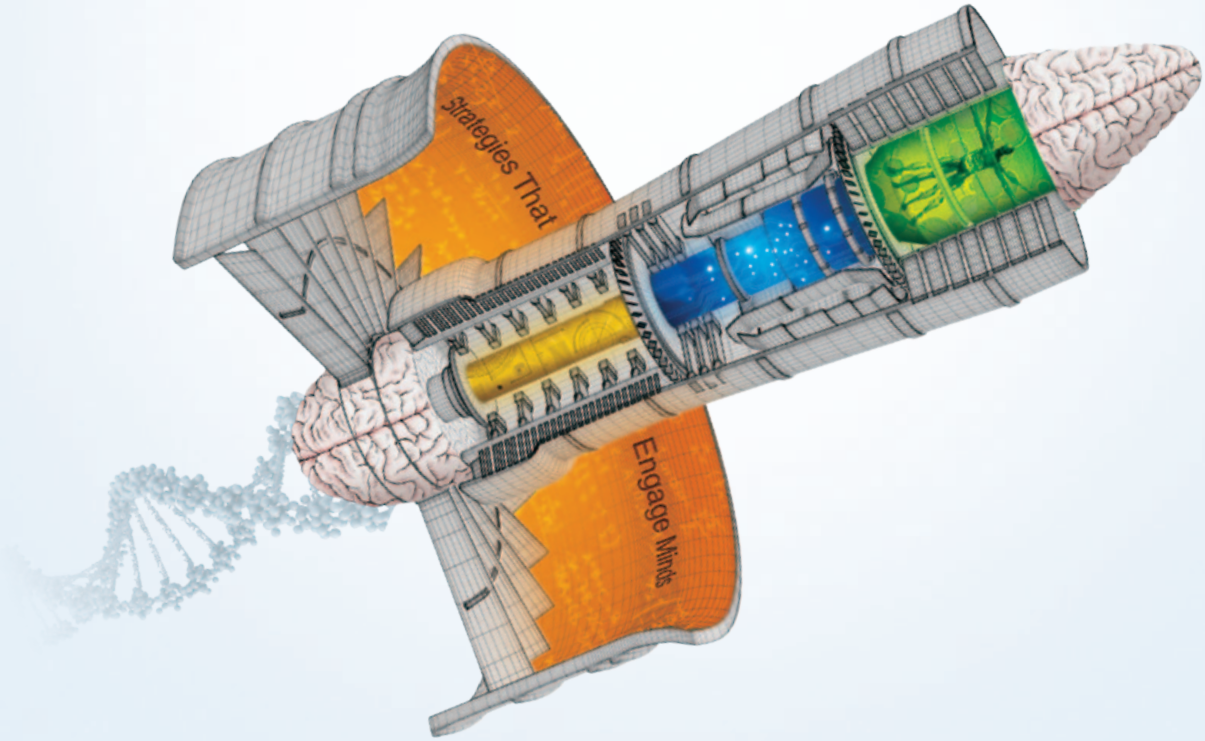
[1]Guillory, F. & Quinterno, J. (2013). *North Carolina: The Shape of Its Change.* The Program on Public Life: UNC-CH

* By 2018 the number of **STEM jobs will increase by at least 17%**. This projection excludes growth in the medical and allied health occupations.
* 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. **North Carolina retains,** on average, **about one-fifth of the primary care physicians it prepares.** The balance of our primary care work force comes from medical school graduates from other states, Canada, and/or other international medical schools.
* According to the North Carolina Institute of Medicine, **NC needs at least three doctors and 10 nurses beginning their practices each day** just to keep up with demand.
* The **growth in primary care** and associated health care services **will require an increase in technical support systems** to manage burgeoning health care demands, including data collection and analysis, claim management, reimbursement distribution, and the like.
* North Carolina currently has 9.8 pharmacists per 10,000 people, well above the national average of 8.0 per 10,000, and the state is improving while the national ratio is declining. However, the maldistribution of pharmacists continues to be an issue in North Carolina.
* The **number of primary care dentists** in North Carolina —4.4 per 10,000 in population—**lags behind the national average** of 6.0 per 10,000 and is maldistributed across the state.
* North Carolina's **23.5 percent job growth in bioscience** since 2001 has been the fastest among the ten largest bioscience employer states.
* The **percentage of high technology businesses** in relation to all business establishments in NC **ranks well below the national average** and only 5th in the South.
* North Carolina ranks **1st in the nation in the number of Nationally Board Certified teachers.**
* North Carolina needs over 10,000 teachers a year, including science and mathematics teachers, but **teacher pay in NC ranks 47th in the US** and only above Mississippi in the South.
* The new economy depends hugely on access to high speed Internet, but in the South only Mississippi ranks below North Carolina, which is 36th in the U.S., in Internet speed.
* NC is the **only state to place students in the top 10 five years consecutively** in the American Mathematics Competitions.

The growth in primary care and associated health care services will require an increase in technical support systems to manage burgeoning health care demands.

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.

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. **The two key questions:** (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?**

In the full ScoreCard, comparisons are made between North Carolina's rankings relative to the U.S. and the other Southern states across a range of fundamental indicators, such as the current state of academic attainment and STEM-related employment, including:

* the percentage of high school graduates;
* access and opportunity for college;
* two-year college and bachelor's degrees in STEM fields;
* STEM employment as a percentage of the workforce by level of degree attainment;
* the impact of R&D and specifically academic research on the gross domestic product of North Carolina;
* high-technology businesses as a percentage of all business establishments;
* biotechnology employment in North Carolina;
* employment of medical doctors, dentists, pharmacists, and of Allied Health professionals and medical/health technicians—the largest employment growth sector in North Carolina.

Selected indicators are featured in this overview of domain one. First, how well has North Carolina frontloaded its educational capacity to compete with other states and internationally for the jobs and the people to fill them?

* Among the 25-44 year old population in NC, 86.8% are high school graduates, as compared to 87.1% in the U.S. That figure places North Carolina as 4th in the South (behind VA, TN, and FL). Nationally, we are in the 3rd quartile, putting us above the national mean.
* Using that same age cohort of 25-44, 35% hold a two-year degree or higher, compared to 39% nationally. That figure puts NC as 2nd

86.8% of 25-44 year-olds in North Carolina are high school graduates. The national average is 87.1%.

65.1% of North Carolina households have broadband internet access, ranking us 38th nationally.

in the South (behind VA, the only Southern state to exceed the national average.)

- In the 25-44 age cohort, the U.S. ranks #11 of OECD[1] countries in this area, well behind Canada, Japan, South Korea and Israel.

International data shows that the U.S. has declined in the rankings of countries in degrees received by its young adults, age 25 to 34. A Lumina Foundation in Education report states that, "…ours is one of the very few nations in the world in which young adults are not better educated than older adults."

Next, how does North Carolina's STEM-related workforce compare as a percentage of the total workforce relative to the U.S. and the South?

The table at the bottom of the page summarizes the data. North Carolina compares favorably with the nation in a number of indicators. However, we rarely lead on any indicator and the state faces stiff competition in the South.

Third, access to high-speed Internet with sufficient Broadband is now critical to the functioning of large and small businesses, hospitals, schools, universities, households and individuals. The Pew Internet & American Life Project reported that 2006 was the tipping point when the Internet exceeded all broadcast media as the source of public science information. So, how does North Carolina compare nationally and in the South in access to high-speed Internet and broadband adoption?

* In North Carolina, 65.1% of households have Internet Broadband access, as compared to 67.94 % in the U.S. 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. South Korea, Japan, Sweden and even Romania have much faster Internet connections than the United States.
* The average internet household download speed is measured by megabytes per

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, & 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, & VA)

Note: North Carolina's productivity relative the U.S. and the South in the areas of research and development, establishment of high technology businesses, and in biotechnology are detailed in the full ScoreCard.

[1] Organization for Economic Cooperation and Development (http://www.oecd.org)

second (Mbps). North Carolina's index rating in February 2013 was 13.06 Mbps, compared to the U.S. index of 15.56. In the South, North Carolina ranked ninth after Virginia, Florida, Tennessee, Georgia, Alabama, South Carolina, Louisiana, and Texas and only higher than Mississippi. North Carolina, ranked 36th in the U.S. The U.S. ranked 34th globally.

STEM Preparation for All

How well prepared and capable is North Carolina to enable its young citizens to compete for and succeed in securing good paying STEM jobs? The state's core intent 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 and 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 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.

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 aimed at traditionally under-represented minority and female students. Getting through the STEM pipeline is rigorous, and this expanded access can serve to broaden and diversify participation for many students who aspire to STEM jobs at the end of the pipeline. 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 NMSQTP 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.

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.**

#36

North Carolina's internet download speed index of 13.06 ranks it 36th nationally, and 9th in the South.

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 informal and free-choice learning landscape filled with science museums, zoos, aquariums, local, state and regional parks, after school community activities such as 4-H, Boys and Girl Clubs, Scouting, the Internet and a vast array of digital resources, television and radio as well as books, magazines and other print media. Research is pointing to the surprising finding 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 eventual adult career choices and to the continuous lifelong learning and STEM literacy of adults.

The engagement of students in state-level STEM competitions, like MathCounts or the NC Science, Engineering and Technology Fair sustain student engagement in STEM. These specialized free-choice competitions offer a special 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 increased STEM career choices as well. So, having these competitions available in abundance across the state matters to the overall goal of advancing a STEM-ready workforce in North Carolina.

The key question: 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, and other forms of self-directed STEM learning?

2,368,027
children participated in STEM programs at North Carolina state and local science museums.

1,000,000
The North Carolina Museum of Natural Sciences is at one million visitors and counting since opening its 80,000-square-foot Nature Research Center wing on April 20th, 2012.

An Excellent Example of What is Possible

On April 20, 2012, the North Carolina Museum of Natural Sciences welcomed its one millionth visitor since opening its new wing, the Nature Research Center (NRC). As is apropos of this section of the ScoreCard, Dr. Patel, a Cary physician, brought his twin daughters to the Museum. Dr. Patel said: "We love the Museum! This is actually our second time coming this week." He also says the girls absolutely love "Meet the Animals" and "Story Time" in the main building.

The Museum aims to bring science to the people—demystifying science and engaging people in research that affects their daily lives. The cutting-edge NRC features *Investigate Labs* where visitors perform experiments, nearly 80 interactive exhibits, a high-tech *Naturalist Center* with touch tables, and a submersible that allows visitors to experience what it feels like to be 2000-feet below the ocean's surface.

The Museum sponsors over 80 STEM-related learning activities scheduled throughout the year, including over 45 summer camp experiences for children on a variety of scientific topics. Consult naturalsciences.org for additional information.

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

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 5 consecutive years
American Regional Mathematics League	30	National competition. NC twice national champions.
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	

5,641,113

Total participation for museums, aquariums and zoos was over 5.5 million. More than 2.5 million children participated in STEM programs at those institutions.

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, after school programs, and student competitions on student learning and STEM engagement.**
3. **Expand networking and sharing STEM resources and data across informal learning and afterschool providers.**

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.

Many programs and organizations described in other domains of the ScoreCard could correctly be described as both strategic and innovative. However, this domain focuses on selected programs and initiatives that have, with one exception, gone unmentioned in other domains. As a group they are unique and largely, 'Tar Heel Born' and contribute in important ways to building the human resource capacity and STEM learning infrastructure of the state. Eclectic as the programs and initiatives described in this domain are, they share one commonality—they all serve the entire state.

The key question: In what ways do the state and the non-public sector sustain and support investments and innovations strategic to STEM learning and economic development?

North Carolina has benefited from leadership in creating and sustaining these strategic and innovative investments, including:

Early Childhood Education: North Carolina was an early national leader in establishing mandatory kindergartens, and is currently a national leader in providing educational opportunities for 4-year olds. Over 24% of the state's 4-year olds participate in these programs.

MCNC: High Speed Internet is essential for economic growth and global competitiveness. 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.

North Carolina School of Science and Mathematics (NCSSM) is the nation's first residential high school devoted to STEM education. The school enrolls 680 in-resident high school juniors and seniors and another 1,586 in distance education programs. Over 3,000 teachers in NC have participated in NCSSM professional development programs.

The Science House is located on the NCSU campus and operates five additional regional offices across the state. This program works with K-12 students and teachers in promoting inquiry-based learning in STEM subjects.

North Carolina School of Science and Mathematics is the nation's first residential high school devoted to STEM education.

39,000,000
North Carolina families watch more than 39 million viewer hours of UNC-TV per year, making it the second most-used state-supported service after the road system. Many of the programs are STEM-related, including stalwarts like *Nature* and *Nova*.

Approximately 32,000 students participate in Science House programs and activities annually. On average, 4,900 teachers and nearly 1,000 school administrators participate in professional development programs annually.

North Carolina New Schools (formerly NCNSP) is a network of small, innovative high schools that push the boundaries of convention about high school. Within the larger network, there are smaller STEM Affinity Networks consisting of schools that focus on: (1) Health and Life Sciences; (2) Energy and Sustainability; (3) Biotechnology and Agriscience; or, (4) Aerospace, Advanced Manufacturing, and Security.

North Carolina sponsors the **Summer Ventures Program in Science and Mathematics**, a summer enrichment program for academically motivated high school students potentially interested in a career in science or mathematics. Last year, 335 students from 57 counties participated.

The **NC Center for the Advancement of Teaching** (NCCAT) is a residential professional development and renewal center for North Carolina's teachers. Teachers attend weeklong seminars on an array of topics, many of them STEM-related, including: scientific discovery about North Carolina's mountains (Islands in the Sky), genetics (Climbing the Double Helix: Is DNA Destiny?), and space (The World from Beyond: Learning and Teaching STEM using NASA Resources).

Kenan Fellows Program: 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.

North Carolina was a first-round recipient of a **Race to the Top Grant** from the federal government. While the major focus has been to reform the public school teaching/learning infrastructure around more rigorous standards (Common Core and Essential Standards) and improved accountability, some significant focus has been provided for STEM.

UNC-TV is a service that has been a part of the state's commitment to its citizens since 1955. Families watch more than 39 million viewer hours per year, making UNC-TV the second most-used state-supported service after the road system. Many programs are STEM related, including First Flight, HealthWise, Human Spark, Nature, and NOVA.

North Carolina sponsors the **NC-MSEN Pre-College Program** to increase the pool of high school students interested in careers in STEM and teaching. Last year, 1,771 high school students participated. Of that number, 96% intended to go to college, and 65% intended to pursue a STEM major.

Burroughs Wellcome Fund (BWF) has sponsored several key initiatives, including $48 million in science education since 1996, and $23.6 million in the Student Science Enrichment Program (nearly 37,000 since 1996). BWF also has invested $5.4 million with the UNC system to develop up to 120 science and/or math teachers through its FastTrack program.

The **Golden LEAF Foundation** and its Board of Directors have, in the past two years, approved two special investments: (1) Over $5 million for a STEM College and Career Readiness initiative in 46 rural school districts, and (2) over $7 million for an Essential Skills in Advanced Manufacturing Workforce Training initiative in 22 community colleges.

North Carolina School of Science and Mathematics (NCSSM)

One of the state's most innovative and recognizable investments lies in its commitment and support to the first residential high school in the country devoted to STEM learning. Each year, 680 juniors and seniors are in residence, enrolled in courses aimed at meeting the state's graduation requirements as well as admissions requirements to the UNC system. Most importantly, the curriculum is heavily loaded with STEM content in addition to courses in the Arts and the Humanities—very much like a college curriculum. Students are also required to engage in service learning and learn to work in teams, and are expected to apply their knowledge beyond the classroom through competitions, colloquia, and conferences.

A total of 7,888 NCSSM alumni are engaged in various endeavors, most often STEM-related, in North Carolina, the U.S. and around the globe.

NCSSM also provides online distance education opportunities in subjects such as Forensic Science, Honors Calculus, Aerospace and Engineering, Honors African American Studies, Honors Genetics and Biotechnology. Last year, 1,586 high school students in NC enrolled in NCSSM distance education courses.

The honors and recognitions earned by NCSSM and its students are impressive:

* Ranked 29th in a listing of the nation's 1,000 top high schools by *Newsweek* magazine.
* Produced nine national finalists and six national winners in the Siemens Competition in Math, Science & Technology, the most of any high school in the nation.
* Won the National Science Bowl in 2010.
* Took first place at the Toshiba Exploravision competition, the world's largest K-12 science competition, for a technology developed to make clean drinking water from condensed water vapor.
* Won the third Singapore International Mathematics Challenge.

Action Items

1. **NCSSM, Science House, Kenan Fellows, NCAAT, 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 after school 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 into every community and household across North Carolina.**

680 juniors and seniors reside each year at the North Carolina School of Science and Mathematics—the nation's first residential high school devoted to STEM education.

DOMAIN FOUR:

College and Career Readiness

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

The majority of STEM jobs will require substantial acquisition of knowledge and skills best obtained through K-12 and post-secondary studies.

The key question: How well prepared are North Carolina children to enter into and successfully navigate the STEM pipeline to be ready to compete for and succeed in the STEM jobs of the future?

K-12 students in North Carolina perform reasonably well on the state assessment in math and science.

Summary of Composite EOG/EOC STEM Scores

(Percentage at or above grade level – level 3)

Subjects	N.C.	Notes
Mathematics (Grades 3-8)	**82.8%**	2011-12 data
Science (Grades 5 and 8)	**76.6%**	Only grades tested in science last year
Algebra I	**78.7%**	Only math test required for graduation
Biology	**83.0%**	Only science test required for graduation

Source: NC DPI (Testing and Accountability Services)

Summary of NAEP Scores in STEM Subjects

(Percentage proficient or better)

Subjects	N.C.	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

However, these same students score lower on the National Assessment of Educational Progress in both mathematics and science.

Achievement in mathematics on the NAEP assessment by North Carolina students is half as high as scores on NC's EOG and EOC. NAEP science achievement reveals that only slightly over a quarter of 8th graders are proficient or better in science.

As students progress along the STEM pipeline, STEM course-taking tends to take on an additional sense of urgency. So many students take Advanced Placement (AP) courses to

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.

Project Lead the Way is part of a national not-for-profit organization that promotes learning pre-engineering knowledge and principles for middle and high school students.

elevate the rigor of their knowledge acquisition and possibility earn college credit. Although not a universally accepted standard for granting college credit, a score of 3 (on a 1-5 scale) is the minimum to receive college credit.

Summary of Advanced Placement STEM Results – 2011-12

(Percentage of students scoring 3 or higher)

Advanced Placement Exam	N.C.
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

These results are somewhat mixed, with some percentages reaching into the 70th percentile, but most in the 50's. The areas that attract the greatest number of participants are Biology, Calculus AB, Environmental Science, and Statistics. What these data do not indicate is the unevenness in participation rates and achievement rates across gender and ethnicities.

At the next level, we look at college admissions. The ACT has established College Benchmark Scores which predict the probability of a student receiving a "C" or better on a related freshman level course in college. The Benchmark score in mathematics is 22, while the Benchmark score in science is 24.

ACT STEM Benchmark Percentages

(Percentage proficient or better)

ACT Test	N.C. Average	Benchmark Score	National Average
Mathematics	22.4%	22%	21.1%
Science	21.4%	24%	20.9%

Source: 2011 ACT Profile Report – State

North Carolina students score above the national average in both science and mathematics on ACT test percentages. NC students outscore all of our Southern neighbors in mathematics and all but Virginia in science. NC students did not achieve the benchmark score of 24 that predicts college success in freshman level science, however, no state reached the science benchmark. NC scored 2.2 points below the highest-ranking state (MA) in mathematics, and 1.8 points below the highest-ranking state (also MA) in science.

Authentic STEM-Learning with Project Lead the Way

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

* Gateway to Technology
* 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. Over 14,500 middle and high school students in North Carolina have participated in PLTW programs. The PLTW network includes 193 trained teachers, 97 counselors, and 100 schools.

Career and Technical Education

Courses and programs in Career and Technical Education (CTE) historically have been regarded as a "dumping ground." In today's quest for people to qualify for and work in the STEM jobs, CTE graduates from our high schools are anything but second class. Over 100 distinct programs in the CTE catalog of offerings from North Carolina's Department of Public instruction require most of the content to be STEM-related. Last year, enrollment in CTE courses with a specific STEM connection reached nearly 805,000. Of the enrollees, over 81% were proficient in their respective CTE standardized assessments. Over 45% of CTE students earned a STEM-related industry certification or credential, qualifying them for an entry-level position upon graduation. How does this translate into the real world? In 2010, the unemployment rate for the 16-19-year old cohort who graduated in CTE was 5.4% in NC. Non-CTE graduates of the same age cohort had an unemployment rate of 27%.

Transition from High School to Post-Secondary Education

Focused efforts underway in NC's K-12 schools to strengthen the transition from high school to post-secondary studies should result in positive benefits for those in the last sector of the pipeline (those preparing to transition from being a student to becoming a member of the workforce), and also contribute to the economic development of the state. The essential question is: Is North Carolina producing high school graduates who can succeed in the post-secondary studies that are essential to be employable in the vast majority of the jobs expected for the remainder of this decade and beyond?

The answer to that question is somewhat mixed. The table below shows how well community college students are prepared and persisting in post-secondary education.

Summary of NC Community Colleges and STEM

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 field	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

The community college system in North Carolina oversees more than 250 distinct STEM-related programs. Of all Associate of Art degrees conferred in the state's community colleges, about 31% were in STEM-related programs. About 45% of students earned both the AA degree and an industry credential or diploma in a STEM program.

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

60%

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

The next essential question is: How does all of the engagement and development translate into STEM job readiness?

Number and Percent of Degrees Conferred in STEM Fields for all NC Colleges and Universities

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

As shown in the table above, the percent of degrees conferred in STEM fields in all of North Carolina's 4-year colleges and universities is 26% of all bachelor's degrees, 29% of all master's degrees, 58% of all academic doctorates, and 45% of all professional doctorates, in this case related primarily to the health professions.

The job vacancies projected for the remainder of this decade warn us of the difficulty facing North Carolina and its ability to fill those jobs. A goal set by The Lumina Foundation for Education recommends that 60% of the US adult population have post-secondary degrees or certificates by 2025 to maintain economic leadership in the world. North Carolina's current rate is 36.9%, behind the national average of 37.9%. To reach the 60% goal, NC would have to increase output by 7% per year, every year. That means increasing degree or certificate-granting productivity by nearly 9,500 *additional* graduates per year, every year. Without any change in the current pattern for producing competent and qualified North Carolinians for those good paying STEM jobs of the future, employers will still have to look elsewhere for the talent and skills they need.

Looking at an Old Issue Through a New Economic Development Lens

A number of achievement gap analyses in North Carolina and across the nation continue to document and report modest improvements according to longitudinal studies on NAEP scores by the National Center for Educational Statistics. The implications for the state's economic development and for the quality of life for citizens of all ethnicities and incomes are significant. As documented in this ScoreCard, STEM jobs (indeed most jobs) of the future will require some post-secondary education to achieve technical or professional certifications or to achieve degree status. Two measures that connect high school achievement with college readiness for success are scores from Advanced Placement (AP) tests and scores on the sub-tests on the ACT College Admissions test.

Consider just three examples from the 2011 AP results for STEM subjects. The percentages in the table below reflect how many AP test takers scored a 3 or higher, a score generally considered the minimum for achieving college credit for a high school course:

Summary of Selected 2011 STEM AP Results by Ethnicity

(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 will have difficulty getting through the STEM pipeline because they appear to be ill equipped with the knowledge and skills for success. Students unable to reach the end of the STEM pipeline will not be ready for STEM jobs.

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.

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

The participation rates by students of color are alarmingly low. It's difficult to increase a desired output when the inputs are so low. U.S. Census data from 2010 show what the 15-24 year old population in North Carolina looked like in 2010:

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

In 2018, these same people will be 23-28 years old, and by 2020, they will be 25-30. These are the very people who, if a significant number have completed post-secondary programs in technical or professional STEM fields, can claim the jobs that hold the promise for North Carolina's economic future. These students, and those to follow, constitute an important investment in the future of North Carolina's economy.

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 post-secondary 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 large body of research backs up the statement that the teacher is the single largest in-school determinant of student success. 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.

The focus of the Teacher Quality domain is on: (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 effectiveness as science and math teachers over their first five years. National Board Certification, an indicator of disciplined teacher self-development, is also featured in this domain. The 2013 NC STEM ScoreCard lists nine indicators and provides data analysis for these three areas, only a few of which are shown on the following pages.

Dr. Charles Thompson and Kristina Patterson of the Carolina Institute for Public Policy at UNC-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. (Please see the table at the top of the following page.)

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

>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.

Licensure Examination Performance

(Percentage of teachers scoring above)

Subject	U.S. 2011-12 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

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. The U.S. Median Score was calculated by the Educational Testing Service using scores of examinees who took the tests between August 1, 2008 and June 30, 2011. Much larger percentages scored above the qualifying score set by the North Carolina State Board of Education.

A second indicator of quality lies in how STEM teachers perform, as determined by their ratings on the state's standards-based Performance Evaluation System. Assuming that a rating of less than "Proficient" would be indicative of an ineffective teacher, any rating at "Proficient" or higher would similarly be indicative of an effective teacher. Data from this Performance Evaluation System can be seen in the table below. With "Proficiency" as a standard, almost all STEM teachers at both middle school and high school levels reached that standard. However, only about half were regarded as performing at a standard of "Accomplished." And, for the most part, fewer than 10% were evaluated as performing at the standard of "Distinguished."

Proficiency on NC Teacher Evaluation Process Standard IV: Teachers Facilitate Learning for Their Students

	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

Another means to gauge teaching effectiveness is to examine how instructional performance translates into measures of student growth, using a statistical model called Educational Value Added Assessment System (EVASS).

The table below shows the percentage of all teachers and elementary, middle, and high school teachers of mathematics and science with an EVAAS index score for 2011-12 at each of three levels of effectiveness: (1) below expected growth, (2) at or near 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.

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.

Having well-qualified teachers teaching the subjects for which they were prepared has been shown by researchers to be related to student achievement. For that reason, one indicator of quality in science and mathematics relates to the qualifications of teachers teaching those subjects in North Carolina.

EVAAS Estimates of Teacher Effectiveness

(Percentage of expected growth)

	Above	Below	Average
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

Nearly 1/3rd 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.

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

		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

As the above table shows, a very high percentage of teachers teaching science and mathematics at the middle and high schools in North Carolina are not fully licensed in these disciplines. While more middle grades mathematics teachers are fully licensed in their subject area than others in the table, nearly 1/3rd 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. This condition impacts thousands of courses and hundreds of thousands of students across North Carolina every school day. Policymakers and the public are likely unaware of the pervasive nature of out-of-field teaching in North Carolina.

The table at the top of the following page 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 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 Carolina Institute for Public Policy could track for at least five years in order to determine teacher persistence. Persistence of middle grades mathematics and science teachers is above the percentage for all teachers, with the exception of high school science teachers, which for reasons unexplained, is well below the average persistence for all teachers in the same time period.

The Persistence of Mathematics & Science Teachers in the First Five Years of Teaching

	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

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North Carolina ranked 47th in the U.S. with average teacher pay of $45,933 for the 2011-12 school year. The national average was $56,069.

A final indicator of quality, in this NC STEM ScoreCard Overview, is the number of North Carolina's STEM teachers that hold National Board Certification awarded by the National Board of Professional Teaching Standards. Teachers receiving this certification are generally well-regarded as outstanding teaching practitioners. North Carolina leads the nation in the number of Board Certified teachers.

Percentage of Teachers with National Board Certification

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

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, 4-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, school leadership priorities most often translate into programs and practices that reflect those priorities.

The key question is: To what degree and in what ways do the public school districts, the NC Chamber, and other statewide initiatives demonstrate explicit priority for and support of STEM outcomes from entry to and exit from the STEM pipeline?

For this section, focused on leadership and policy support in school districts, we administered a survey to 115 school districts in the state asking about practices that are indicative of STEM support. Seventy-four responded. Key findings from the survey are presented in the following table.

Summary of School District Survey Responses

Selected Indicator	Percentage "Yes"
Have a STEM-specific focus on the district's website	51.4%
Have a 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%

The survey responses indicate that district leadership supports and encourages STEM initiatives at the school level, but does less well in creating a STEM focus at the district level. A more thorough analysis of this domain can be found in the full ScoreCard.

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.

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.

Exemplary School District Initiatives

In **Caldwell County Schools**, district administrators and the Board of Education used local and external funding sources to transform a one-time private school facility into the district-wide Patterson Science Center, which provides a series of hands-on science experiences for classes. The district's use of the resources has served the triad of professional development, program development, and materials/equipment acquisition.

In **Asheboro City Schools**, the district reports having a "task force" of broad representation that advised the district on securing a grant from the Golden Leaf Foundation. Activities from 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. This group has helped move the district's STEM focus forward, including offering new courses in robotics, engineering, biotechnology, and health careers.

Alleghany County Schools has an advisory group made up of teachers, school and district administrators, community college representatives and local government officials that oversees STEM efforts. STEM-related activities include: funding from the Golden Leaf Foundation; a teacher who is a Burroughs Wellcome Fund Career Award winner; integrating STEM in afterschool programming; state-level wins for the robotics team and solar powered transportation team (and displaying their solar cars at the NC Science Museum 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.

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

There are many other outstanding STEM initiatives in North Carolina, in public schools, post-secondary institutions, and local or regional STEM learning centers. We welcome receiving descriptive information and impact data to include in future versions of this STEM ScoreCard.

Other Sources of Support

The **Golden Leaf Foundation** is North Carolina's most generous foundation in terms of the total amount of charitable giving, providing funding solely for people and organizations in North Carolina. The Foundation was created in 1999 by the North Carolina legislature to administer half of the state's share of the settlement from cigarette manufacturers. From its inception, Golden LEAF has been committed to directing funds to projects with the most potential for bolstering North Carolina's long-term economy, especially in tobacco-dependent, economically distressed, and/or rural communities.

Golden LEAF's grant making priority areas include projects that provide educational opportunities and increase economic vitality. Golden LEAF has funded 1,133 grants totaling more than $498 million. In 2010-11, the Foundation launched a $4,000,000 STEM initiative to provide three-year grants of up to $750,000 to help develop STEM capacity for middle schoolers, particularly underserved minorities, females, and children from families with limited resources.

The **NC Chamber**, an important voice in North Carolina, has drafted a comprehensive plan for accelerating job growth. The plan is framed around four "pillars of a secure future," one of which is *Education and Talent Supply*, articulated as follows: "North Carolina must 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. This includes the state's K-12 public schools, network of state community colleges, state university system and independent colleges and universities."

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.**

$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.

Priority Action Items

Additional **Action Items** were developed in this ScoreCard and can be seen at the end of each domain analysis and in the full ScoreCard.

STEM Workforce and Economic Impact

1) 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.

Informal Education and STEM Literacy

2) 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.

Strategic Investments and Innovation

3) Learning in schools will soon be characterized by students with constantly connected mobile devices, requiring ubiquitous wireless access. Even the smallest districts should have 1G of connectivity to NCREN. Every high school should be connected at a minimum of 500Mbps to the district network, each middle school at a minimum of 250Mbps, and each elementary school at a minimum of 100Mbps. A concerted effort must also be undertaken to ensure that all students have broadband access at home by the beginning of the 2016-2017 school year, when the state plans to migrate to digital textbooks and assessments. The minimum speed for home access should be 4Mbps download and 2Mbps upload to support the needs of students.

College and Career Readiness

4) The General Assembly should create a post-secondary 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.

Teacher Quality

5) 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.

6) *Centers of Excellence in STEM Teacher Preparation* should be established through 6-8 regional consortia of community colleges, public and private institutions and public schools with a goal of reducing duplication, leveraging resources and meeting 100% of the demand for fully licensed STEM teachers within five years.

Leadership and Policy Support

7) 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 school 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 assets. However, research uncovered several deficiencies that need to be addressed.

North Carolina has the possibility of a very bright economic future if the state can maximize its strengths and assets. 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 aware of STEM career possibilities. And North Carolina has a wide variety of STEM-related innovations and investments that are admirable —with pockets of excellence.

But, we also discovered these realities:

* While people 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 that are 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. Part of the issue is the under-supply of allied health professionals and the shortage of primary care physicians produced within our institutions. The community colleges, public universities and independent colleges are well aware of these conditions and need to be supported to address the issues with greater success.
* High speed Internet access is truly the essential ingredient for a vibrant and equitable economic future for North Carolina. Our state and business interests need to 'double-down' on their investments and leverage federal funding to extend this critical asset across the state.
* Most critically, North Carolina, like many states, does not ensure that underrepresented minorities, females, and children from low-income homes 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 for 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

A large number of people and organizations gave their time, talent and attention to help the Project Team develop this first comprehensive statewide STEM assessment for North Carolina. These people are acknowledged below. A complete listing of individuals with job titles and their organizational affiliations is provided in the full ScoreCard. We also want to apologize in advance for inadvertent omissions of people who provided assistance to this project and to those who feel they could have made a valuable contribution to this work, if they had been asked. This is the first STEM ScoreCard, but not the last one, so please contact anyone on the project team to let us know how we might improve the next ScoreCard.

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